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BOTANY.—*Certain Cactaceae of Venezuela: New and old species of* Opuntia *and* Melocactus.[1] H. PITTIER, Caracas, Venezuela.

In the course of my botanical work in Venezuela, I have become closely acquainted with some of the Cactaceae which form one of the main elements of the thorn-bushes of this country. Besides, I have now in cultivation and under observation a few doubtful species. The following are the first results of my investigations.

Opuntia metuenda Pittier, sp. nov. (Cylindropuntiae-Leptocaules)

Horrida, insolite armata, trunco ramisque lignosis, teretibus, decumbentibus vel interdum suberectis; areolis parvis cano-villosis, parce vel haud glochidiatis, aculeis 1–3, nudis, porrectis, flavescentibus, uno longiore, armatis; articulis teretibus, dissitis, plus minusve alternis, caducissimis; foliis parvis, crassis, obovoideis, acuminatis, cito caducis; areolis articuli cujusque 22–28, 3–4 inferioribus inermibus aculeatisve vel setis rigidis rubescentibus instructis, reliquiis superioribus 1-aculeatis, aculeo nudo, longo, aciculari, flavescenti, interdum aliisque 1–2 obsoletis adjectis; glochidiis inconspicuis vel nullis; floribus parvis, luteis; ovario obovato, areolis paucis, glochidiatis vel raro apicem versus 1–2 aculeis instructo; perianthio plus minusve rotato, segmentis exterioribus brevibus latisque, minute apiculatis, interioribus obovato-spathulatis, basi angustis, apice obtusis subacuminatisve; staminibus numerosis, flavescentibus, filamentis tenuibus, antheris oblongo-linearibus basifixis; stylo flavo, crasso, apicem versus attenuato; stigmate magno, purpureo, 6–8-lobulato; bacca obovoideo-globosa, matura rubra, areolis fere inermibus, glochidiatis, interdum armatis.

Caudices 40–120 cm. longi, 1.2–1.5 cm. diam.; articuli 4–6 cm. longi, 0.8–1 cm. diam. Aculei 1.5–4 cm. longi. Folia 3 mm. longa. Flores plus minusve 3 cm. longi, 1.5–2 cm. diam. Petala interiora 1.5–1.7 cm. longa, 1–1.5 cm. lata. Stamina plus minusve 1.5 cm. longa. Stylus (cum stigmate 3–4 mm. longo) 1.5 cm. longus. Bacca 1–1.2 cm. diam.

LARA: Savannas around Barquisimeto, June 28, 1913 (*Pittier* 6415); Barquisimeto, in ravines descending to Rio Turbio, flowers and fruits, September 18, 1923 (*Pittier* 11176, type). The above description was drawn (flower and fruit) from this latter specimen and partly from living plants in my garden obligingly sent from Barquisimeto by Brother Nectario of the La Salle College, to whom I extend my best thanks. From recent information it appears that the species is far from being restricted to the vicinity of Barquisimeto. Dr. A. Jahn reports it as growing abundantly in the hills

[1] Received October 24, 1935.

that surround Lagunillas (Mérida), at an altitude of about 1000 to 1200 meters. It is also said to be common in arid places through the State of Falcón and in eastern Venezuela around Cumaná (Sucre). Thus, the altitudinal range of the species would be from sea level to about 1200 meters.

Opuntia metuenda is known locally as *guasabar, guasábara, tuna de guasábara* (Lara), *guasábana* (Sucre).

Opuntia bisetosa Pittier, sp. nov. (Platyopuntiae-Elatiores)

Planta elata, e basi ramosa; articulis ovato-oblongis obovatisve, crassiusculis, pallide viridibus; areolis fere 7-seriatis, 6 vel 7 in quaquam serie[2] (marginalibus exceptis); aculeis areolarum juvenilium 5 vel minus, primum lutescentibus demum albidis; aculeis areolarum maturarum 8–10, robustis, albidis, 1 centrali, erecto, longiore, compresso, distorto, 7–9 brevioribus, acicularibus, plus minusve obliquis, inferioribus pluries setis 2, longis, rigidis, suffultis; foliis tenuibus, elongatis, subteretibus, subtiliter apiculatis, apice purpurascentibus; floribus modice magnis; ovario obconico, areolis 8-seriatis, 5 quaquam serie, inferioribus glochidiatis setaceisque, superioribus 1–3-aculeatis, albo-glochidiatis, aculeis albis, pilis brevibus rufescentibus cinctis, basi foliis 1–2 deciduis suffultis; foliis marginalibus 5, brevissimis, crassiusculis, apice spinulosis; perianthio cupuliformi, segmentis exterioribus late obovatis truncato-apiculatis, interioribus obovatis, apice rotundatis emarginatisve, basi virescentibus, apice incarnatis; staminibus numerosis, filamentis pallide roseis, antheris minutis, albis; stylo crasso, apicem versus leviter attenuato, albo; stigmate magno, subgloboso, pallide viridi, 8-lobulato; bacca ovata, omnino saturate rosea, superne aculeata, aculeis tenuibus brevibusque; seminibus albis.

Planta, ut videtur, usque ad 1.2 m. alta. Articuli usque ad 36 cm. longi, 18 cm. lati. Areolae 3–4 cm. remotae. Aculeus centralis usque ad 5 cm. longus. Folia 4–5 mm. longa. Flores 6.5 cm. longi, 5 cm. diam.; folia marginalia 5–6 mm. longa; perianthi segmenta interiora 2.8 cm. longa, 1.8 cm. lata; stamina circa 1.8 cm. longa; stylus 2–3 cm. longus; stigma 5–7 mm. diam. Bacca 5 cm. longa, 2.2 cm. diam., aculeis tenuibus usque ad 11 mm.

This description was drawn from a living plant obtained from a joint collected at Sanare, State of Lara, by Mr. Fr. Tamayo and cultivated in my garden. The species seems to be allied to *Opuntia wentiana* Britt. & Rose, from which it is easily distinguished by the two bristles at the base of the inferior spines in the areoles of the joints. Botanical specimens distributed under *Pittier* 13578 (type).

Opuntia wentiana Britt. & Rose, Cact. 1: 116. 1919

Plant erect, much branched; joints ovate, obovate or elliptic, thickish, whitish green and covered in age with tiny white dots which give them a glaucous appearance; areoles 4 to each oblique row (marginal not included); spines on young joints mostly 3, later 4 to 6, to each areole, strong, terete, at first yellowish, turning to light gray; leaves early deciduous, thick, rounded, the apex spinulous, more or less purplish; flowers medium-sized; ovary obconical with 5 oblique rows of areoles, these 4 to the row and leav-

[2] According to my experience with the Venezuelan *Platyopuntiae*, the seriate disposition of the areoles on each face of the joint and the number of areoles in each row are fairly constant and constitute a good specific character. The same can be said of the leaves on the upper margin of the ovary.

ing the base of the ovary smooth and spineless; areoles spineless or with 1 minute spine, with a central tuft of white glochids surrounded by a narrow cushion of brown cellular hairs; at the base of the areole a short, thick, apiculate leaf; calycinal leaves 5–6; segments of the perianth broadly obovate, the outer ones shorter, more or less greenish, minutely apiculate, the inner ones larger, yellow, often tinged with pink near the apex, slightly emarginate; stamens numerous, the upper part of the filaments and the anthers pale pink; style whitish, its base thick, rounded, pointed at the base and attenuate towards the apex; stigma lobes 5–6, parted, cream colored, forming a subglobose head; fruit rather small, rounded at base, spineless but glochidiate, the umbilic very deep.

Joints 20–25 cm. long, 12–13 cm. broad. Leaves 3–5 mm. long. Distance between areoles in row 4–5 cm. Major spine up to 7 cm. long (on the average 4–5 cm.). Flowers 6 cm. long, 6 cm. diam. when fully open. Calycinal leaves 2 mm. long. Inner segments of perianth 3 cm. long, 2.5 cm. broad. Stamens 1.8–2 cm. long. Style (including stigma head 7 mm.) 2.7 cm. long. Fruit about 3 cm. long, 2.2 cm. diam.

But for the leaves, which are not subulate, and the inner segments of the perianth, of a darker yellow (turning to pink in age) and not acute, the above described plant agrees with the incomplete description of *Opuntia wentiana* as given by Britton and Rose and should at all events be keyed in the same group, which includes *O. caracasana*, *O. wentiana* and the new *O. bisetosa*. From the first one, the flowers and fruits of which are not known, it differs in the habit, the larger joints, the thick, turgid leaves and the spines, longer and mostly more numerous.

The above description was made from living specimens in my garden, obtained from a joint brought from El Tocuyo, State of Lara, by Mr. Fr. Tamayo. Herbarium specimens are being distributed under *Pittier* 13577.

Melocactus amoenus (Hoffmannsegg) Pfeiffer, Enum. Cact. 43. 1837

Melocactus caesius Wendland in Miquel, Nov. Act. Nat. Cur. 18, Suppl. 1: 184. 1841.

Melocactus griseus Wendland, l. c., p. 185.

Cactus amoenus Hoffmannsegg, in Preiss, Verzeich. ed. 7, 22. 1833.

In their standard work on Cactaceae, Britton and Rose give brief descriptions, under the names *Cactus amoenus* and *C. caesius*, of two supposedly distinct species of *Melocactus*, the first growing on the northern coast of Colombia, the other on the coast of Colombia and Venezuela. A mere comparison of the meager descriptions of these two species would incline one to the belief that they are identical. The given differentiating character "spines curved" and "spines straight" is too vague and inconstant, since perfect specimens of the Venezuelan *M. caesius* have always more or less curved spines.

Britton and Rose give Colombia as the type locality of *Melocactus amoenus* but in the second edition of Förster's *Handbuch der Kacteenkunde* we read[3]

[3] Carl Friedrich Förster's *Handbuch der Kacteenkunde in ihrem ganzen Umfange*, . . . von Theodor Rümpler. Zweite ganzlich umgearbeitete Auflage, pp. 425–426. 1886.

[translated]: "Fatherland Venezuela, where *Ed. Otto* found it up to an altitude of 1600 m. in the vicinity of La Guaira, growing on a red clayey soil among *Agave*, large columnar *Cerei* and *Opuntiae*. It existed there in considerable numbers and in all possible forms and sizes." Continuing, the *Handbuch* gives a description of the plant, which is wanting only in the characters of the fruit and seeds, and which applies accurately to most of the specimens I have handled: "Body conical-depressed, at first globose-depressed, grayish green. Ribs 10–12 [10–15] obtuse, not very salient; areoles white [to gray], [2.5 cm.] distant, sunken, but at first roundish; spines straightish, stiff, subulate, spreading, at first reddish, later dark brown; radial spines 8, the upper ones [usually shorter, 1 cm. and up] very short, the inferior ones very long [up to 3 cm.]; central spine solitary, erect, almost always absent on young individuals. Cephalium vaulted, whitish [with red bristles and spines]. Flowers in July, [1.7 to] 2.5 cm. in diameter when fully open, which happens in the afternoon only, the segments of the perianth pinkish red, long-lineal, spreading. [Fruit about 3 cm. long, obclavate, red]. One of the prettiest and most freely blooming species. Reaches a height of 15 to 18 cm., with a diameter slightly larger. The extirpation of the cephalium results sometimes in the production of new buds."

The additions between [ ] are mine and complete the description.

Further on we have a description of *Melocactus caesius*, which has 10 ribs, instead of 10 to 12, on a globose-depressed body, the areoles grayish, 2.5 cm. distant, the spines strong, stiff, straightish, pale reddish, the radial ones 8, spreading, the central one shorter. The flowers completely developed measure 15 to 18 mm. in diameter, the pinkish red segments of the perianth are lineal, and obtuse or emarginate at the apex, the stamens and the 7 lobes of the stigma yellow.

According to these descriptions, much more accurate than the ones of Rose and Britton, the two species would differ in the shape of the adult body, the number of the ribs, the color of the areoles, the length of the central spines and the diameter of the flowers, all characters very variable in any species. Moreover the *Handbuch*, after describing a variety *griseus* of *M. caesius*, with 15 ribs, adds that in all probability *M. caesius* and *M. griseus* are only forms of *M. amoenus*.

My own observations fully confirm this last view. In a single station, in a group of a large number of individuals of the same ancestry, all the types included under the descriptions of *M. amoenus*, *M. caesius* and *M. griseus* were represented. The form of the body is far from constant, the number of ribs varies from 10 to 15, the color of the areoles is either gray or white, the spines are seldom straight, the radial ones almost always 8 and of variable length. The color of the flowers is almost uniform but their size is reduced in the poorer forms, in which also the spines do not attain their full development.

For these reasons, I think that *Melocactus caesius* and *M. griseus* should be considered as synonymous with *M. amoenus*, which is the oldest name. It is even doubtful whether the forms described under the two first names ought to be considered as fixed varieties.

The type of *M. amoenus* was probably from the vicinity of La Guaira, Venezuela, and not from Colombia. The original description dates from 1833, that is from a time when the secession of Venezuela from Great Colombia in 1830 had hardly become generally known. There is no mention of any botanist or collector having visited the arid parts of the coast of Colombia in the few years previous to the first publication of the species, while in Caracas several persons, stimulated by the example of the illustrious Vargas, were interested in the flora of the surrounding region and may have sent to Europe samples of such striking plants as the one in question.

Melocactus amoenus appears almost everywhere in the arid parts of the coast of northern South America, including the islands, between Trinidad and Santa Marta. It is very doubtful whether the specimens photographed by Dr. Stahel in the interior of Dutch Guiana belong here. The cephalium of these plants, as it appears in the picture published in Britton and Rose (Cactaceae **3**: 234) is much larger and more prominent than in our species. I also think that the upper altitude of 1600 m. cited in the translation from Förster's *Handbuch* is exaggerated. To my knowledge, the species does not appear above 1000 m. and reaches its fullest development in the warmest stations, not far distant from the seashore. The plant also appears scattered in the semi-desert districts around Barquisimeto, El Tocuyo and Carora, in the State of Lara.

PALEOBOTANY.—*Field identification of the fossil ferns called* Tempskya.[1] ROLAND W. BROWN, U. S. Geological Survey.

Tempskya is a genus of fossil ferns whose remains, so far as now known and understood, are found in place exclusively in strata of Cretaceous age. Unlike the attractive black impressions of the fronds of Carboniferous ferns and seed-ferns commonly illustrated in textbooks and exhibited in museums, specimens of *Tempskya* are rough, irregularly cylindrical or conical blocks (Fig. 5) resembling some occurrences of fossil wood. The foliage of ferns, it may be noted, has been found in the same or contemporaneous strata as the *Tempskya* trunks, but the two have never been found in direct connection and consequently, no definite correlation between foliage and stems has yet been made. Because *Tempskya* has considerable value as a

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stratigraphic indicator, and because collections made in the past few years have revealed the fact of its occurrence at numerous Cretaceous localities in the western United States, it is deemed appropriate now to emphasize the importance of looking for and collecting specimens of this genus, and, as an aid to the collector, to show how *Tempskya* may be recognized in the field and distinguished from other fossil plant materials with which it might be confused.

The first American specimens of *Tempskya* to be described were collected from the Patapsco (Lower Cretaceous) formation exposed in the valleys of Stony Run and Deep Run, north of Severn, Anne Arundel County, Maryland, and were named *T. whitei* by E. W. Berry (1) in honor of Dr. David White, of the U. S. Geological Survey. Although the cell structure in these specimens is silicified, it is poorly preserved, but enough is present to substantiate clearly the reference to the genus, which was first defined from European material. The original European tempskyas came from a number of horizons and localities. The first to be described were from Wealden (Lower Cretaceous) deposits in Tilgate Forest and the beach near Ecclesbourne, Sussex, England. They were called "arborescent ferns," and later, *Endogenites erosa*, implying affinity with monocotyledons, possibly palms. The name *Tempskya*, in honor of Friedrich Tempsky, the discoverer of several specimens in gravels along the River Elbe, east of Neupaka in Bohemia, Czechoslovakia, was given by Corda (2), who described four species in 1845, making *T. pulchra* the nominal type of the genus. However, the first fairly complete generic characterization was published by Kidston and Gwynne-Vaughan (3) in 1911, for it was based upon an excellently preserved specimen, which they called *T. rossica*, collected from Tertiary gravels (most probably derived from the erosion of nearby Upper Cretaceous deposits) in the basin of the Karaganda River on the west flank of the Mugodjar Mountains, Russia. Tempskyas have also been recorded from the Wealden in northern France and near Hanover, Germany; and from the Perucer beds (Cenomanian, Upper Cretaceous) near Lana, 35 kilometers west of Prague, Czechoslovakia.

In 1908, A. C. Silberling, of Progress, Mont., found a specimen of *Tempskya*, 33.5 cm. long, in sediments then thought to be of Kootenai (Lower Cretaceous) age, but now known to be of lower Colorado (Upper Cretaceous) age, in the Musselshell Valley about 10 miles southeast of Harlowton, Mont. This well-preserved specimen was not described until 1924, when Dr. A. C. Seward (4), of Cambridge,

England, named it *T. knowltoni* in honor of Dr. F. H. Knowlton, of the U. S. Geological Survey.

C. H. Wegemann, of the U. S. Geological Survey, in 1910, collected a specimen from a sandstone in the Thermopolis shale (Upper Cretaceous), 25 feet below the Mowry shale, in sec. 28, T. 41 N., R. 81 W., near Kaycee, Wyo. Although it posseses a number of well-defined stems embedded in a groundmass of roots, this specimen was not recognized as *Tempskya*, but was reported as "rootlets" on page 64 of U. S. Geological Survey Bulletin 471, 1912.

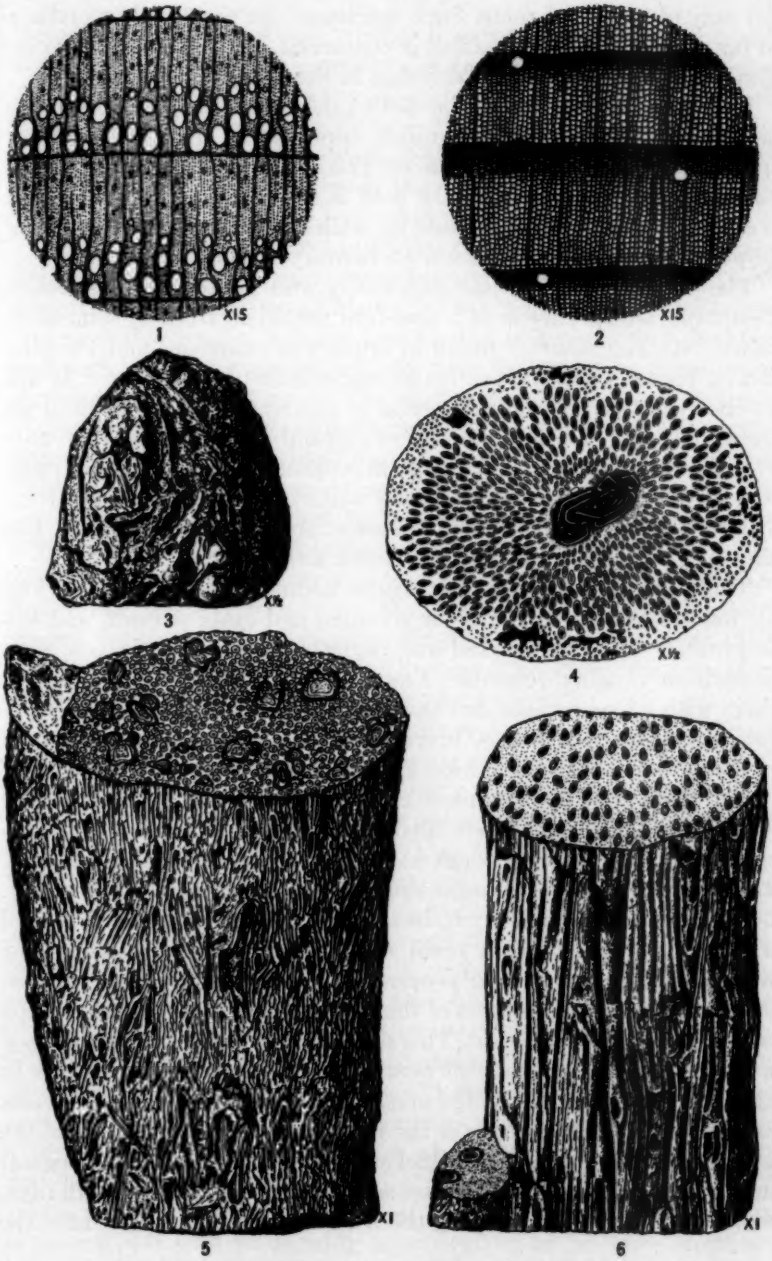
In recent years during the course of field work various members of the U. S. Geological Survey have collected additional characteristic material in the Cretaceous terrains of Idaho, Wyoming, Utah, and Nevada. The Idaho specimens were collected by G. R. Mansfield, W. W. Rubey, and J. S. Williams, and were found at two horizons—the weathered uppermost beds of the Wayan formation, of Colorado age, in the Lanes Creek quadrangle to the southeast of Grays Lake; and an especially prolific locality in the Aspen shale, also of Colorado age, in sec. 19, T. 5 N., R. 44 E., of the Teton Basin. Most of the Wyoming specimens were collected by W. W. Rubey and J. S. Williams from the Aspen shale, in the northeast corner of the Afton quadrangle; but one water-worn specimen was found by the writer in a gravel terrace resting upon the Green River formation in the valley of Twin Creek, near Fossil. The only specimen from Utah was collected by Frank L. Hess, of the U. S. Bureau of Mines, from Upper Cretaceous deposits near the head of Pack Creek just west of Mount Peale in the La Sal Mountains. The Nevada specimens were found by W. W. Rubey and Eugene Callaghan in the lower part of the Overton fanglomerate about 6 miles southwest of Kaolin, Clark County.

The material in the recent collections makes it possible to differentiate several new species, but the description, illustration, and naming of these species, together with a precise statement of their stratigraphic implications, is reserved for more elaborate treatment than is possible here. As an illustration of the stratigraphic significance of *Tempskya*, however, it may be stated that the Nevada specimens collected by Rubey and Callaghan have served, in conjunction with other plant fossils, to demonstrate satisfactorily that the portion of the Overton fanglomerate containing them is Cretaceous in age, not Miocene (?) as now designated (5). Because the plant and animal fossils found in many continental sediments are, at best,

so fragmentary, scarce, and lacking in diagnostic features that, with the limitations of our present knowledge, they are of little value as stratigraphic indicators, it becomes a matter of some importance to search for and collect such outwardly unprepossessing objects as *Tempskya* trunks and other petrifactions, which have well-preserved internal structures and can be identified with certainty as belonging within a given geologic range.

The aspect of *Tempskya* specimens depends somewhat upon the characteristics of the formation from which they originate. In external color or tone they may differ considerably, according to the weathering they have undergone, but internally, when well-preserved, they are usually dark. In size they may be as small as the specimen illustrated in Figure 5, or they may be a foot in diameter and several feet long. Their shape is generally roughly cylindrical or conical, with a surface that is irregularly corrugated, ridged, or furrowed, small holes sometimes terminating the broken ends of the curved rounded ridges. The transverse surface (see top of Fig. 5), especially when wet, usually reveals a number of scattered, irregularly circular or lobed bodies, from 0.5 to 1 or more centimeters in diameter, enclosing minute horseshoe-shaped figures and surrounded by a groundmass of thousands of closely packed, small, circular or elliptic structures. The former are cross-sections of a dichotomously branched stem with leaf traces; and the latter are sections of adventitious roots, forming a mat or felt around the stems. The whole constitutes in effect a trunk, called a false stem, that has become silicified. The corrugations on the external surface are thus seen to be portions of roots. When sufficiently magnified the stems are seen to consist of a prominent ring of xylem (wood) surrounded by a cortex composed of large-celled, thin-walled parenchyma; and an outer zone of thick-walled sclerenchyma. The conspicuous features of the roots are their almost uniform size and the presence of large-celled xylem elements arranged in the form of a cross. In the older parts of *Tempskya* trunks, roots may sometimes be found invading the stems. It should be stated that not all *Tempskya* blocks show the presence of stems; some may represent the outer or lower portions of a large trunk and thus con-

Fig. 1.—Transverse section of white ash, *Fraxinus americana*. Fig. 2.—Transverse section of western yellow pine, *Pinus ponderosa*, with three resin canals. Fig. 3.—A coal ball. Fig. 4.—Transverse section of *Psaronius gutbieri*. After Corda. Fig. 5.—*Tempskya knowltoni*, showing stems embedded in a groundmass of circular to elliptic adventitious roots. Fig. 6.—Piece of *Palmoxylon* sp. The fragment near the base, showing sections of two adventitious roots, is not a part of this trunk. All figures are somewhat diagrammatic and lack some details not considered necessary of delineation for the purposes of this paper.



For explanation of Figs. 1–6, see bottom of opposite page.

sist only of a mass of roots. Such specimens are practically worthless so far as specific determination is concerned, but are valuable as indicating the presence of a *Tempskya* in the formation.

How may the tempskyas be distinguished in the field from other petrifactions of somewhat similar appearance? Excepting a few species of ferns, the confusion of *Tempskya* with the usual plant petrifactions encountered in the field is unnecessary if the collector is armed, as he invariably should be, with a hand lens of at least 10 to 14-power, and has learned a few elementary anatomical facts.

The common fossils that genetically and anatomically simulate *Tempskya* are specimens of a tree-fern genus, *Psaronius*, sometimes called "starling stones," found in upper Carboniferous and Permian strata. Figure 4 illustrates a transverse section of a *Psaronius*. It will be observed that the central portion of this section represents a single stem composed of a large number of concentrically arranged, arcuate vascular bundles, which, if viewed in longitudinal section, would present a system having a very complex pattern. Adventitious roots form a protective periphery around the stem. As a whole, this trunk, like that of *Tempskya*, could also be called a false stem.

Those irregular, rounded or angular nodules called coal balls (Fig. 3), found in strata of the Pennsylvanian and other periods, and unfortunately often overlooked and neglected by field geologists, may sometimes roughly resemble *Tempskya*. However, examination of them with a lens reveals that usually they are composed of a heterogeneous mixture of stems, leaves, roots, and other organs derived perhaps from as many different species of plants.

The plant petrifactions most commonly encountered in Mesozoic and Cenozoic formations are silicified or lignitized trunks of gymnosperms (cycads, ginkgos, conifers) and angiosperms (monocotyledons, dicotyledons). Of the gymnosperms the conifers are most frequent, but they will be least likely to be confused with *Tempskya*. A typical living conifer with which fossil conifers may be compared is the western yellow pine (*Pinus ponderosa*), of which Figure 2 is a transverse section revealing parts of four annual rings, the darker portion of the rings being late wood. This section consists of radially disposed wood elements (tracheids) of nearly uniform size, and resembles in appearance a wall constructed of small, hollow tiles. The darker color and apparently smaller size of the tracheids in the late growth of the annual ring is caused by the thickening of the cell walls. At irregular intervals the rows of tracheids are separated by thin, radial, pith rays; and, scattered sparsely among the tracheids, generally in or near the

late wood, are a few, large, circular openings, denoting resin canals. Such a section showing *tracheids and resin canals* is normally characteristic of the wood of that group of conifers which includes the pines, spruces, larches, and Douglas firs. Presenting sections similar to that of a pine, but *normally without resin canals*, is the other coniferous group that includes the true firs, hemlocks, sequoias, junipers, cedars, cypresses, and bald cypress.

Perhaps the petrifactions most likely to be confused with *Tempskya* are found among the monocotyledons, namely, fossil palm trunks or portions thereof. Figure 6 shows the weathered, ropy, external surface of a *Palmoxylon*, a transverse section of a portion of the stem, and some external material near the base, but not part of this stem, showing adventitious roots. The distinctive feature that separates *Palmoxylon* from *Tempskya* is the presence, as seen in cross-section, of numerous oval or bottle-shaped, more or less radially directed, fibrovascular bundles, consisting of a small vascular portion with several large vessels (xylem) and a larger, usually darker, fibrous portion composed of sclerenchyma. The transverse sections of the adventitious roots are normally larger than those in *Tempskya* and under low magnification have the appearance of two concentric circles. Specimens of *Palmoxylon* consisting of roots are most likely to be mistaken for *Tempskya* with stems, and those showing fibrovascular bundles for *Tempskya* with roots.

Contrasted with conifers and monocotyledons, the woody dicotyledons are distinguished by the presence of numerous relatively large vessels distributed conspicuously among the smaller elements. These vessels may be concentrated in the spring wood or beginning of the annual ring, as in the white ash (Fig. 1), or they may be spread rather evenly throughout the annual ring. The former are the *ring-porous woods* and include the oak, chestnut, sassafras, elm, mulberry, ash, locust, and catalpa. The latter are the *diffuse-porous woods* and include the walnut, hickory, birch, willow, poplar, sycamore, red gum, beech, cherry, maple, tulip tree, buckeye, and linden. A word of caution here is necessary to the effect that gradations between ring-porous and diffuse-porous woods are not uncommon and that the vessels of some species, such as the willows and poplars of the diffuse-porous group, are sometimes so numerous and small that even with a 14-power hand lens these species when poorly preserved as fossils may be mistaken for conifers.

It is regrettable that the study of fossil wood has not yet been as systematically and thoroughly organized as to be more generally

applicable to the solution of stratigraphic problems. The reason for this backwardness lies neither in the lack of good material (in the field) nor in the availability of equipment required for such studies, but principally in the failure of geologically-biologically educated students and acceptable materials to meet under favorable auspices. Both the geologist and the plant-anatomist are in part to blame for this state of affairs—the geologist for collecting uncritically and the anatomist for rejecting the poor material with unconcealed disdain—the whole performance resulting in general discouragement. It is hoped, however, that this unfortunate impasse can presently be overcome and that all good specimens of *Tempskya*, fossil wood, and other plant petrifactions may receive adequate attention. The collector should be advised that acceptable collecting will be seasoned with discrimination and will provide representative specimens, not necessarily bulky, but showing the essentials required for identification, such as the stems in *Tempskya*, the central core or pith in gymnosperms and angiosperms, as the case may be, and a generous portion of the best development of the wood. Thus, because fossil wood usually occurs as broken trunks or stumps of such large size as to dismay the uninformed collector, it becomes a matter of exercising nicety of judgment in selecting, with the help of a hand lens, only typical portions that have well-preserved features of diagnostic value.

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ZOOLOGY.—*The histology of nemic esophagi.* V. *The esophagi of* Rhabditis, Anguillulina, *and* Aphelenchus.[1]

B. G. CHITWOOD, Bureau of Animal Industry, and M. B. CHITWOOD.

This is the fifth paper of a series dealing with the structure of the esophagi of various groups of nematodes. In the previous papers (Chitwood and Chitwood, 1934–1935) the histology of the esophagi of *Rhabdias eustreptos, Oesophagostomum dentatum, Heterakis gallinae,* and *Metestrongylus elongatus* has been described. The nomenclature in this paper is the same as that used in previous ones.

[1] Received March 13, 1935.

In the present paper, the esophagi of *Rhabditis terricola* and *R. lambdiensis* are described in full, while descriptions of the esophagi of *Anguillulina dipsaci* and *Aphelenchus avenae* are given in brief and in the form of a comparison with those of the species of *Rhabditis*.

THE ESOPHAGI OF RHABDITIS TERRICOLA AND R. LAMBDIENSIS

Both of these species were studied in detail, the results being nearly, but not entirely, identical. The description is based on *R. terricola*, comparisons with *R. lambdiensis* being made where differences were noted. Illustrations were made of the species of which the best sections were available.

GROSS MORPHOLOGY. The esophagus of *Rhabditis terricola* is 144 to 172μ long and consists of 3 major parts: A corpus distinctly subdivided into an anterior part, the precorpus, 58 to 70μ long, and a posterior part, the postcorpus, 24 to 34μ long; an isthmus 30 to 42μ long; and a bulb 30μ long. The precorpus is cylindrical, some of its tissue extending anteriorly and surrounding the mesostom and telostom. The lumen of the precorpus is somewhat subtriangular at the base of the stoma; immediately posterior to this point it becomes triradiate, each radius terminating distally in a small, incomplete "tube." In *R. lambdiensis* these "tubes" are much larger than in *R. terricola*. The "tubes" gradually become smaller in the posterior part of the precorpus and disappear in the postcorpus. The postcorpus takes the shape of a fusiform swelling commonly called the "median bulb"; its lumen is triradiate, the walls of the radii converging distally. The isthmus is a long, narrow region, the lumen being similar to that of the precorpus. The bulb is pyriform and contains a well developed valvular apparatus which alters the shape of the lumen. The cuticle lining the anterior part of the value is relatively thin, the lumen subtriangular to triradiate according to the stage of contraction. This is followed by the esophageal valve which consists of thickened parts of the cuticular lining to which muscles are attached.

NUCLEAR DISTRIBUTION. *Precorpus.* There are 18 nuclei in the precorpus of which 12 are of nerve cells (n_{1-12}) and 6 are of the radial muscle fibers (r_{1-6}). The nerve cell nuclei are arranged in 4 groups of 3 nuclei each, 1 nucleus being in the center of each esophageal sector. The first group (n_{1-3}) is situated a short distance from the anterior end of the corpus; the second, third, and fourth groups (n_{4-6}, n_{7-9}, and n_{11-12}) are situated in series, one behind the other. The radial nuclei (r_{1-6}) are arranged as a single group of 6 nuclei, 1 on each side of each esophageal sector, the group being situated near the base of the precorpus and between the third and fourth groups of nerve cell nuclei. In *Rhabditis lambdiensis* the same number of nuclei are present as in *R. terricola*, but the fourth group of nerve cell nuclei (n_{11-12}) is situated anterior to the radial nuclei (r_{1-6}).

Postcorpus. There are 28 nuclei in the postcorpus, comprising 6 radial

nuclei (r_{7-12}), 3 marginal nuclei (m_{1-3}), and 19 nerve cell nuclei (n_{13-31}). The marginal nuclei are situated near the anterior end of the postcorpus, 1 at the end of each esophageal radius; these nuclei are usually bilobed, the lobes being designated *a* and *b* (see m_{1a}, etc., in Fig. 1). This lobing of m_{1-3} is discussed in the description of the nuclei. The radial nuclei (r_{7-12}) are situated near the middle of the postcorpus and arranged as in the case of the first group (r_{1-6}). The nuclei of the nerve cells are arranged as a chain in the dorsal sector ($n_{13,16,23,28,29}$) and similarily in each subentral sector ($n_{14,17,19,21,24,26,30}$ and $n_{15,18,20,22,25,27,31}$). The nuclei in each sector are situated near the center of the sector, but the distance from the lumen varies considerably; for the

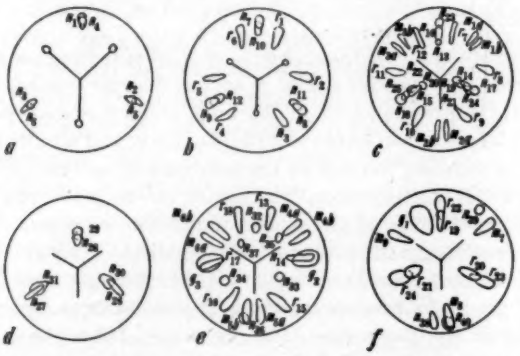

Fig. 1.—*Rhabditis terricola;* diagrammatic representation of the esophagus, a–b, precorpus; c–d, postcorpus; e–f, bulb.

relative positions see Figs. 1–2. The 3 most posterior nerve cell nuclei (n_{29-31}) are situated just posterior to the orifices of the subventral esophageal glands 1 being external to each of the 3 gland masses.

Isthmus. No nuclei are present.

Prevalvar region. The prevalvar and valvar regions of the esophagus are not distinctly separate. Contraction of the valve changes the relative positions of nuclei and for that reason the nuclei of the valvar region are included with those of the prevalvar region. There are a total of 17 nuclei in this region as follows: 6 radial nuclei (r_{13-18}), 3 bilobed marginal nuclei (m_{4-6}), 6 nerve cell nuclei (n_{32-37}), and 2 gland cell nuclei (g_{2-3}). The marginal nuclei are situated near the anterior end of the prevalvar region at the ends of the esophageal radii, 1 lobe lying on each side of each radius (Fig. 1). The radial muscle nuclei (r_{13-18}) are situated 4 to 10μ posterior to the marginal nuclei, 1 on each side of each sector. These nuclei are nearer the center of their sectors than those of the previous radial nuclei (r_{1-6} and r_{7-12}). The nerve cell nuclei n_{32-34} are situated near the posterior level of the radial nuclei, 1 in the center of each sector. The nerve cell nuclei n_{35-37} are situated 4 to 6μ posterior to n_{32-34}, 1 on each side of the dorsal sector, n_{35} being near the lumen at the

right side and n_{37} near the margin of the sector on the left side. The gland nuclei (g_{2-3}) are in the lateral parts of the subventral sectors or sometimes in the lateral parts of the dorsal sector; their position may be at the posterior level of the radial nuclei (Fig. 1) or at the level of n_{37}.

Postvalvar region. The postvalvar region contains 13 nuclei as follows 6 radial nuclei (r_{19-24}), 3 marginal nuclei (m_{7-9}), 3 nerve cell nuclei (n_{38-40}), and 1 gland nucleus (g_1). The radial nuclei are arranged in 2 groups of 3 nuclei each (r_{19-21} and $_{22-24}$), 1 nucleus in the center of each sector, the first group being 3 to 6μ anterior to the second group and nearer the lumen than the second group (Fig. 2). The marginal nuclei (m_{7-9}) are arranged as a single

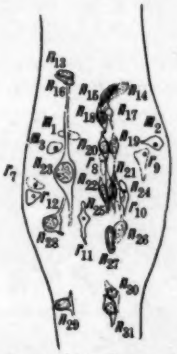

Fig. 2.—*R. lambdiensis;* longitudinal reconstruction of postcorpus.

group, 1 nucleus being at the side of each esophageal radius; their relative position varies considerably. The nerve cell nucleus n_{38} is situated on the right side of the ventral esophageal radius, whereas n_{40} is situated on the left side of the same radius and n_{39} on the dorsal side of the left subdorsal radius. The gland cell nucleus g_1 is near the posterior end of the postvalvar region on the right side of the dorsal sector.

ESOPHAGO-INTESTINAL VALVE. The esophago-intestinal valve is comparatively large and well developed in *Rhabditis* and consists of a trilobed internal structure and a circular external structure. Seven nuclei have been observed in these structures, but it is difficult to determine with certainty which nuclei belong to each of the two parts. Their positions vary somewhat, but usually there are 2 subdorsal nuclei, 2 dorsolateral or lateral nuclei, 2 subventral nuclei, and 1 ventral nucleus.

CHARACTER OF NUCLEI. The radial nuclei each contain 1 nucleolus or sometimes 2 nucleoli, moderately large in either case, surrounded by a nucleoplasm having little or no affinity for stains. The radial nuclei of the first group (r_{1-6}) are oval in cross section, (Fig. 3a); they are very much compressed longitudinally and often quite long. The radial nuclei of the second group (r_{7-12}) are similar to those of the first group in being oval in cross sec-

tion (Fig. 3b), but they may not be quite as elongate longitudinally (Fig. 2). The radial nuclei of the third group (r_{12-18}) are less oval in cross section (Fig. 3c), and not elongated longitudinally; there is considerable irregularity in shape. The radial nuclei of the fourth group (r_{19-21}) are nearly spherical and rest in a densely staining cytoplasm (Fig. 3e) which appears to be very similar to the cytoplasm of the esophageal glands. The radial nuclei of the fifth group (r_{22-24}) are usually somewhat compressed (Fig. 3f), their shapes depending on the state of contraction of their associated muscles.

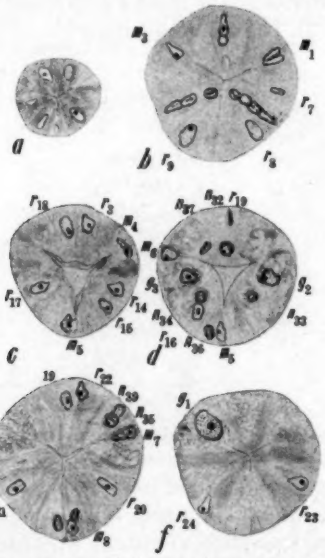

Fig. 3.—*R. terricola;* cross sections of the esophagus. a, precorpus at level of n_{1-6}; b, postcorpus, compare with Fig. 1a; *R. lambdiensis* c–f, bulb (serial sections).

The marginal nuclei are similar to the radials in that the nucleoplasm has little or no affinity for stain and each nucleus contains 1 or 2 nucleoli. The marginal nuclei of the first and second groups ($m_{1-3,4-6}$) are usually bilobed, each lobe containing a nucleolus. The lobes are joined anteriorly (Fig. 3 b–d). The third group of marginal nuclei (m_{7-9}) are similar in character to those of the second groups but not lobed (Fig. 3e). The nuclei of the first and second groups of marginals are apparently not lobed in *Rhabditis lambdiensis* (Fig. 2).

The nuclei of the esophageal glands (g_{1-3}) are larger than other nuclei of the esophagus with the exception of the nuclei of the fourth group of radials (r_{19-21}); they are generally similar to r_{19-21} being somewhat spherical and having 2 large nucleoli. The dorsal esophageal gland nucleus (g_1) is the largest nucleus of the esophagus (Fig. 3f), while the subventral nuclei (g_{2-3})

are of about the same size as the radial nuclei (r_{19-21}) (Fig. 3d). The nucleoplasm contains a few coarse basophilic granules and there is often a dense basophilic margin adjacent to the inconspicuous nuclear membrane.

The nuclei of the nerve cells of the esophagus differ from the other nuclei in that the nucleoplasm has a very definite affinity for basic stains. The basophilic material is concentrated next to the nuclear membrane for the most part, but clumps of granular material are present also near the center of the nucleus. Nucleoli were not always observed in the nerve cells but quite often a bilobed nucleolus was seen. The nerve cell nuclei are spherical or slightly elongated, and are so consistent in appearance that they may be easily recognized by reference to Figures 2 and 3. The protoplasm surrounding the nerve cell nuclei is relatively meager and no particular study of it was made. The neurones of the precorpus (n_{1-12}) all appear to be bipolar, as do all except 3 (n_{26-28}) of the postcorpus (Fig. 2). The exceptions (n_{26-28}) are neurones of the commissure which is situated in the posterior part of the postcorpus. The nerve cells which are situated posterior to n_{29-31} may be commissural cells also. The nerve cells of the prevalvar region (n_{32-36}) are commissural cells of the prevalvar and valvar region, while the remaining nerve cell of this region (n_{37}) and those of the postvalvar region (n_{38-40}) are probably a part of a postvalvar commissure; the later commissure has not been observed with certainty.

ESOPHAGEAL GLANDS. There are 3 esophageal glands, 1 dorsal and 2 subventral. The dorsal gland opens at the base of the glottoid apparatus through a very short transverse duct lined with cuticle. This duct dilates distally from the orifice, forming an ampulla which may or may not be lined with cuticle (facts uncertain). A narrow tube not lined with cuticle extends posteriorly from the ampulla through the middle of the dorsal sector. In the precorpus this tube is surrounded by a very meager amount of glandular protoplasm. In the postcorpus the glandular mass becomes a little larger and branches from the tube have been observed, and in the isthmus the glandular mass is represented only by a delicate strand of protoplasm. The dorsal gland becomes larger and lobed posterior to the valve and is most concentrated in the right side of the dorsal sector where its nucleus lies. The glandular protoplasm at the level of the nucleus is reticulate or facuolate.

The subventral esophageal glands open into the lumen of the esophagus near the base of the corpus, between the levels of the nerve cell nuclei n_{28-29} and n_{29-31}. Like the dorsal gland, each has a short transverse duct lined with cuticle which is connected with an ampulla; the protoplasm of the gland is rather extensive and reticulate in this region, the reticuli being apparently in direct communication with the lumen of the ampulla. The subventral gland masses become narrow and strand-like in the isthmus and remain of this character in the anterior part of the prevalvar region. In the posterior part of the prevalvar region and in the valvar region the gland masses are multilobed and reticulate.

THE ESOPHAGUS OF ANGUILLULINA DIPSACI

The esophagus of *Anguillulina dipsaci* (Fig. 4) cosists of the same general regions as the esophagus of *Rhabditis*, but differs in that the corpus and isthmus are proportionately thinner, and the bulbar region is cylindroid

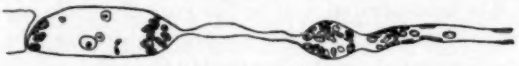

Fig. 4.—*Anguillulina dipsaci;* longitudinal reconstruction of esophagus.

instead of pyriform and is entirely devoid of valves. This type of posterior swelling has been termed a pseudobulb although it is homologous with the bulb of *Rhabditis*. The lumen of the entire esophagus is greatly reduced (Fig. 5), being scarcely distinguishable except in the postcorpus (Fig. 5).

The precorpus apparently contains either 15 or 18 nuclei the arrangement and nature of which were not determined. The postcorpus contains 25 nuclei (Fig. 5) which appear to consist of 2 sets of radial nuclei (r_{1-6}, r_{7-12}), 1 set of marginal nuclei (m_{1-3}), and 10 nerve cell nuclei (n_{1-10}). These designations, it should be noted, were made on the basis of comparison with *Rhabditis* and not on purely structural grounds. The isthmus is exceedingly minute in cross

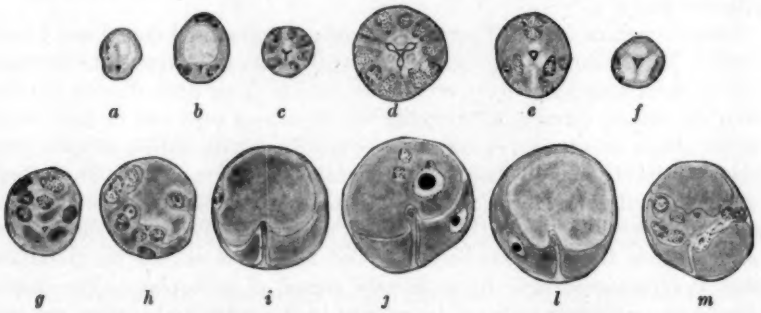

Fig. 5.—*A. dipsaci;* cross sections of esophagus. a–b, precorpus; c–f, postcorpus (serial sections); g–m, bulbar region (serial sections).

section and, like other forms, contains no nuclei. The bulbar region is most interesting, for although 30 nuclei have been found as in *Rhabditis*, there is practically no similarity in other respects. The musculature is exceedingly degenerate, and the esophageal gland tissue massive. Small nuclei are grouped near the anterior and posterior ends of the bulbar region (Fig. 5) with no apparent symmetry. The dorsal and subventral esophageal gland nuclei stand out in contrast, being of much greater size than the other nuclei. As shown by Goodey (1929), the dorsal esophageal gland opens into the esophagus at the base of the stylet and the subventrals open at the base of the postcorpus.

THE ESOPHAGUS OF APHELENCHUS AVENAE

The esophagus of *Aphelenchus avenae* is similar to that of *Anguillulina* with several outstanding exceptions, the most conspicous being the more massive development of the postcorpus and the degeneration of the bulbar region, the latter feature allowing the esophageal glands to lie in the body cavity. We find but 10 nuclei in the precorpus and 33 in the postcorpus (Fig. 6), the total number being the same as in *Anguillulina*. Of the 33 nuclei in the postcorpus, 15 (r_{1-12}, m_{1-3}) appear to check with those in *Anguillulina*, but the different arrangement of the remaining 18 nuclei makes their recognition impractical. The bulbar region appears to have 30 nuclei arranged without apparent symmetry (Fig. 6). Only the 3 esophageal gland nuclei

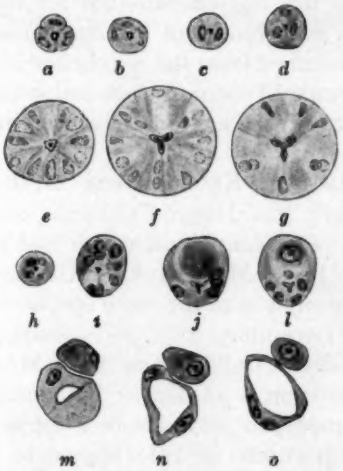

Fig. 6.—*Aphelenchus avenae;* cross sections of esophagus. a–d, precorpus; e–g, postcorpus; h–o, bulbar region.

are clearly recognizable. One point is notable, namely, that the esophageal glands, which extend posteriorly as a cylindroid mass of tissue, are surrounded by a nucleated covering. The fibrous tissue corresponding to these nuclei probably represents marginal or radial fibers. Goodey (1929) found that the dorsal esophageal gland opens in the anterior part of the postcorpus, whereas the subventrals open in the usual position; the writers were not able to verify or disprove this observation, but on the basis of sections it appears probable that he is correct.

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ZOOLOGY.—*The occurrence of the terrestrial amphipods,* Talitrus alluaudi *and* Talitrus sylvaticus, *in the United States.*[1] CLARENCE R. SHOEMAKER, U. S. National Museum. (Communicated by MARY J. RATHBUN.)

The first record of the occurrence of a strictly terrestrial amphipod in the United States is that of Dr. J. Paul Visscher and Chester S. Heimlich (Science, **72**: 560, 1930). In 1930 they reported *Talitrus alluaudi* Chevreux abundant in a greenhouse at Columbus, Ohio, where they say it had survived for more than two years. In 1931 specimens of this species from a greenhouse at Flemington, New Jersey were sent to the Nation Museum for identification. These are the only known occurrences of *Talitrus alluaudi* in America.

T. alluaudi was described from the Seychelles Islands in 1896 where it occurs in rotton trunks of coconut trees and in the humus of forests. In temperate countries, however, it has been reported only from greenhouses.

In 1918 and 1919 Mrs. Kate Stevens, of the Natural History Museum, Balboa Park, San Diego, California, sent to the National Museum specimens of an amphipod which had been found upon a sidewalk in Balboa Park. Mr. Frank F. Gander in 1927 sent the Museum excellent specimens of the same species which he had found in Balboa Park. In December, 1934, and January, 1935, Prof. S. F. Light of the University of California sent the Museum further specimens of this species from a garden in Pasadena, California. Upon careful study, this amphipod proved to be *Talitrus sylvaticus* Haswell, and Mrs. Stevens' specimens of 1918 appear to be the first of this species to be taken in America.

The specimens sent to the Museum by Professor Light were secured in October, 1934, at Pasadena by Mrs. Merwin, who, in a letter to him, says, "The pests came during the recent rains in such quantities that they had to be cleared out of the gutters and literally shoveled from in front of the door. They even came into the house under the front door, but were dead when we found them. They seem to come up alive, and of a dark color, from between the bricks around the front door, though also found in garden gutters." In a later letter to Professor Light, dated November 17, 1934, she says, "The amphipods which you requested reappeared. In yesterday's rain they were found, though not in the former quantity, in our garden and a friend also reports them in Arcadia, which is about five miles east of Pasadena."

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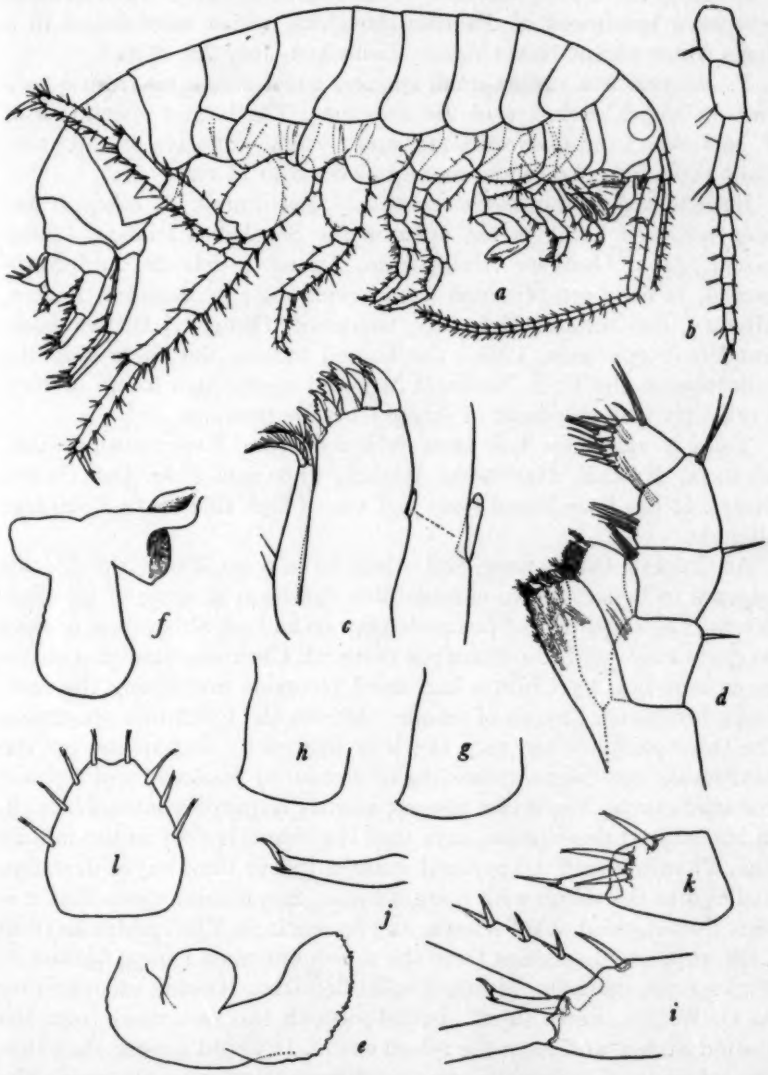


Fig. 1.—*Talitrus sylvaticus* Haswell, female. *a*, entire animal. *b*, antenna 1, top view, enlarged. *c*, maxilla 1. *d*, maxilliped. *e*, branchial vesicle of gnathopod 2. *f*, branchial vesicle of peraeopod 4. *g*, pleon segment 2. *h*, pleon segment 3. *i*, distal end of peduncle of uropod 1. *j*, spine at distal end of peduncle of uropod 1, enlarged. *k*, uropod 3. *l*, telson.

Recently there were sent to the National Museum for identification seventeen specimens of *Talitrus sylvaticus*, which were found in a dog's water pan at New Orleans, Louisiana, July 25, 1935.

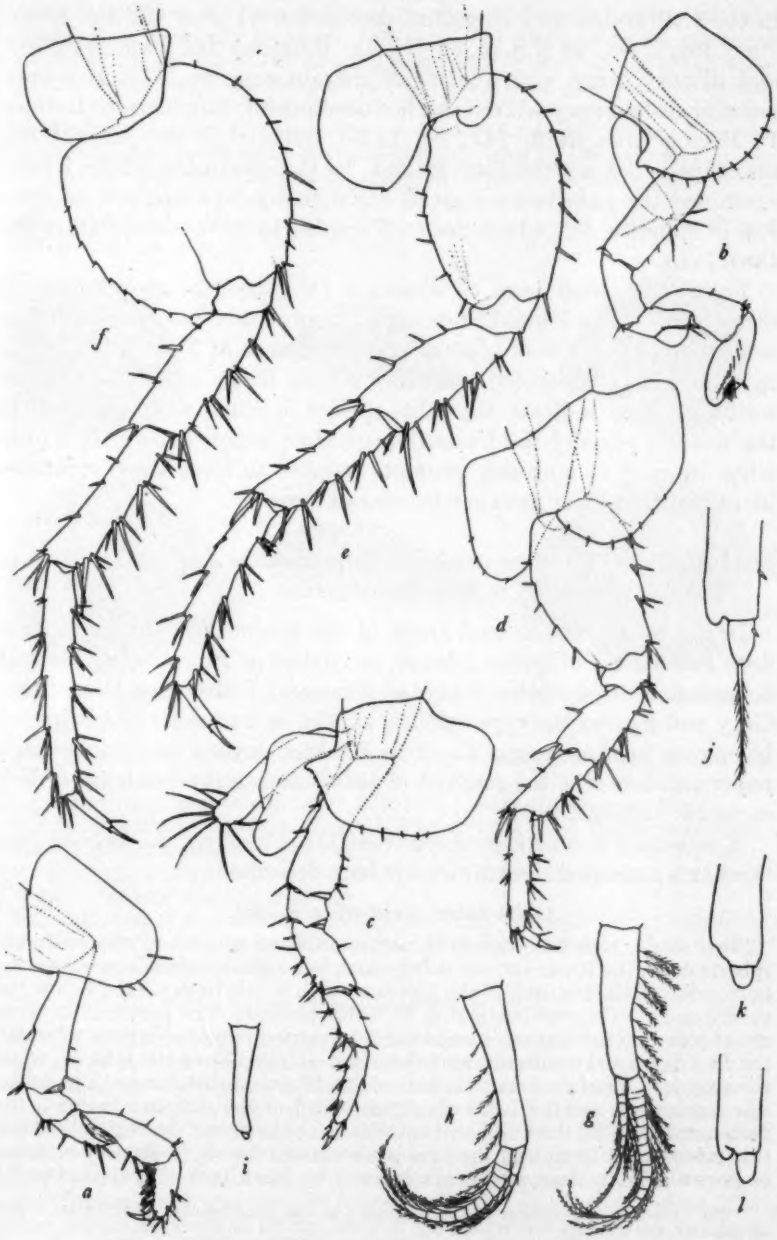
T. alluaudi is a rather small species, which measures from 5 to 7 mm. in length exclusive of the antennae. The largest specimens of *T. sylvaticus* from California measure 13 mm. exclusive of antennae, while those from Louisiana measure from 5 to 11 mm.

Both of these amphipods are widely distributed. *T. alluaudi* has been recorded living in the open at the Seychelles Islands, Madagascar, Java, Gambier Archipelago, Taumotu Islands, and Mangareva. It has been recorded from greenhouses in Belgium, France, Monaco, Switzerland, Germany, Denmark, Hungary, British Isles, Sweden (Stephensen, 1935), the United States, and there is in the collection of the U. S. National Museum a specimen found in New York City in a shipment of celery from Bermuda.

Talitrus sylvaticus has been recorded from New South Wales, Victoria, Hawaii, Marquesas Islands, and now from the United States. It has been found from just above high tide up to 2,520 feet altitude.

As Calman, Stephensen, and others have pointed out, this species appears to be subject to considerable variation in some of its characters. The third pair of pleopods may be lacking altogether, or may be quite small with the branches vestigial. Chevreux said that specimens sent him by Chilton had third pleopods resembling the first, being biramous, though of smaller size. In the California specimens the third pleopods are very much as figured by Stephensen for the Marquesas specimens, consisting of a reduced peduncle and a single vestigial ramus. The telson also apparently is quite variable. Haswell, in his original description, says that the telson is cleft in the middle line. Thomson said it appeared quite entire to him. Sayce describes and figures the telson with margin entire. Stephensen states that it is cleft for one-third of the length, and figures it so. The specimens from California and Louisiana have the telson entire as I have figured it. Two specimens in the Museum collection from Hawaii, identified by A. O. Walker, agree in all characters with the specimens from the United States, and have the telson entire. It would appear then that the telson in *T. sylvaticus* may be either entire or partly cleft. The outer plate of the maxillipeds is rather broad, and rounding distally

Fig. 2.—*Talitrus sylvaticus* Haswell, female. *a*, gnathopod 1. *b*, gnathopod 2. *c*, peraeopod 2. *d*, peraeopod 3. *e*, peraeopod 4. *f*, peraeopod 5. *g*, pleopod 1. *h*, pleopod 2. *i*, pleopod 3. *j*, *k*, *l*, distal end of pleopod 3, enlarged.



For explanation of Fig. 2, see bottom of opposite page.

in the Californian and Hawaiian specimens, whereas Chilton (Jour. Proc. Royal Soc. of N.S.W. **50**: 84, fig. 3) figures this plate as narrow and distally acute with the inside margin concave. This is a very peculiar discrepancy which I cannot account for. Stephensen (Bernice P. Bishop Mus. Bull. **142**: 20, 1935) states that the palp of the maxillipeds has a small fourth joint. In the specimens which I have examined the palp bears a small distal fleshy lobe marked off by a row of spinules, but which does not appear to be separated from the third joint.

Talitrus alluaudi may be expected to appear in greenhouses in other parts of the United States, as it is probably transported in the soil around the roots of plants. The occurrence of *Talitrus sylvaticus* in such widely separated localities as San Diego and New Orleans would seem to indicate that this species is much more common in the warmer parts of the United States than is now known. It is only when interest or curiosity prompts persons to have these creatures identified that their presence becomes known.

MALACOLOGY.—*Two new land shells from the Philippine Islands.*[1]

PAUL BARTSCH, U. S. National Museum.

In my paper on the land shells of the genus *Obba* from the Mindoro Province, Philippine Islands, published in Bulletin 100, volume 6, part 8, United States National Museum, I discussed *Obba listeri* Gray and figured the type species, as well as a number of subspecies belonging to this group. To these I added several more races in a paper published in the Journal of the Washington Academy of Sciences **24**: 318–323, 1934.

A collection recently received from Mr. Frederick S. Webber contains two unnamed races which are here described.

Obba listeri webberi, n. subsp. Fig. 1

Shell small, rather elevated, the spire forming a regular, almost hemispheric cone, the lower surface being much less rounded. Nuclear whorls 2.1 horn colored, the last half of the last turn with a pale brown band below the suture and another one occupying a median position. The postnuclear turns are of pale buff ground color and bear interrupted bands of brown, of which the first is near the summit, and the other a little above the middle, while the anterior half of the whorls is flecked and blotched with brown. The under side has an interrupted band about one-third of the distance between the peripheral keel and the umbilicus anterior to the keel, and the region between this interrupted band and the keel is also marked with flecks and blotches of brown. The nuclear whorls are marked by faint lines of growth. On the

[1] Published by permission of the secretary of the Smithsonian Institution. Received October 23, 1935.

postnuclear whorls the lines of growth increase in strength and are strongly marked, very decidedly so on the last turn. The malleations are strongest anterior to the middle of the turns. The under surface is also strongly malleated and here the malleations extend almost to the umbilicus. The lines of growth here are even stronger than on the spire. The inner half of the base, including the umbilicus, is marked by well incised spiral striations. The umbilicus is rather narrow and about one-third covered by the parietal lip. The last whorl is constricted behind the inner lip, while the outer lip is decidedly deflected. The aperture is oval, slightly angulated at the periphery; peristome moderately thickened and reflected, the inner lip bearing a strong median tooth within.

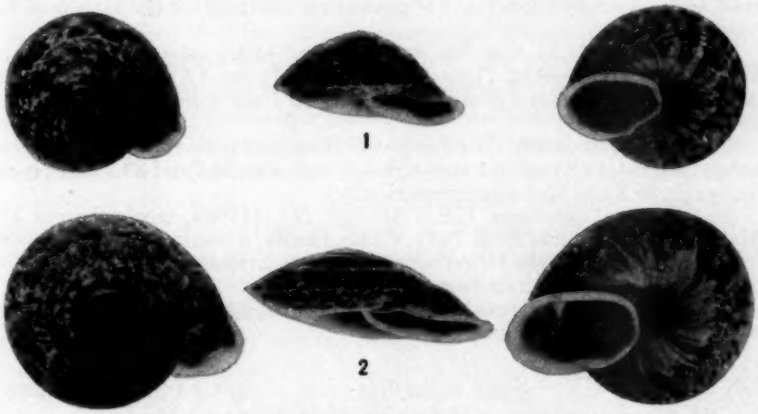


Fig. 1.—*Obba listeri webberi*, new subspecies. Fig. 2.—*Obba listeri catanduanensis*, new subspecies.

The type, U.S.N.M. Cat. No. 314057, was collected near the lighthouse on Tres Reyes Island near Marinduque. It has 4.6 whorls, and measures: Height, 12.8 mm.; greater diameter, 25.5 mm.; lesser diameter, 21.0 mm.

U.S.N.M. Cat. No. 314058 contains 3 paratypes from the same station, while 7 additional specimens are in Mr. Webber's collection. The lot yields the following average measurements: Height, 12.8 mm.; greater diameter, 25.9 mm.; lesser diameter, 21.3 mm.

This subspecies is much more elevated, with the spire more regularly conic and the base comparatively more flattened than any of the other named races of *Obba listeri*.

Obba listeri catanduanensis, n. subsp. Fig. 2

Shell of medium size, lenticular, of flesh colored ground color, mottled and splotched with dark chestnut brown on the upper surface and also on the outer half of the lower surface. Nuclear whorls 2.3 in the type, horn colored. The first half unicolor, while the succeeding portion shows a brownish flush near the suture and a median, rather broad brown band. The postnuclear portion of the shell shows the brown markings, arranged in more or less regular spiral zones, an interrupted band near the summit, a more or less median broken band and the rest fulgurated and mottled with brown. The nuclear whorls are marked by fine lines of growth, which are a little stronger

near the summit and increase in strength as the mollusk adds to the substance of the shell. The postnuclear whorls are strongly acutely keeled at the periphery, which flares slightly upward, and the surface is marked by malleations which are strongest on the outer half of the whorls, and somewhat irregular impressed spiral lines, which are coarser on the upper portion of the whorls. Suture poorly impressed; periphery sharp. The base is moderately arched, the outer half of the last whorl is strongly malleated, the inner half finely spirally striated. The lines of growth here are of the same strength as on the spire. The umbilicus is moderately open, and the shell is constricted immediately behind the inner lip, while the upper lip is decidedly bent upward. The aperture is broadly oval; peristome moderately expanded, thickened and reflected. A low tooth is present on the inside of the middle of the basal lip.

The type, U.S.N.M. Cat. No. 314056, is one of 3 specimens sent to us by Mr. Webber collected at Virac, Catanduanes. It has 4.5 whorls, and measures: Height, 10.6 mm.; greater diameter, 32.1 mm.; lesser diameter, 25.7 mm.

Two paratypes in Mr. Webber's collection yield the following measurements: Height, 12.8 and 12.1 mm.; greater diameter, 31.7 and 33.2 mm.; lesser diameter, 25.8 and 25.8 mm., respectively.

An additional specimen, U.S.N.M. Cat. No. 311069, received from Mr. Maxwell Smith, comes from Batu, Catanduanes, a station not far removed from Virac. It yields the following measurements: Height, 10.6 mm.; greater diameter, 32.8 mm.; lesser diameter, 24.7 mm.

This subspecies in general form resembles the typical race, but is much smaller and of much darker coloration.

ENTOMOLOGY.—*Some butterflies from eastern Virginia.*[1] AUSTIN H. CLARK and LEILA F. CLARK, U. S. National Museum.

Since the days of Boisduval and Le Conte the butterflies of eastern Virginia have received little attention. Various collectors have visited the region, but only a few notes on some of the more unusual species have been published.

We have made a preliminary reconnaissance of this area, visiting Accomac and Northampton Counties on July 20–27, 1935, Princess Anne County on September 23–24, 1934, and Norfolk and Nansemond Counties on September 1–3, 1935. Although our time was limited, we feel that we secured a fairly complete representation of such butterflies as were flying when we were in any given locality, and therefore that our list is sufficiently detailed to serve as a basis for future intensive work.

Included in the list are records of nine species from Bayford, Northampton County, kindly given us by Dr. Florence Walker of Bayford, and of one from Lake Drummond which we owe to the courtesy of Dr. Paul Bartsch. With these included our list totals sixty-nine species.

[1] Received October 26, 1935.

We are under great obligations to Dr. Hugo Kahl, of the Carnegie Museum, Pittsburgh, Pa., who was so very kind as personally to bring to Washington the type specimens, male (Figs. 7, 8) and female (Figs. 5, 6), of *Atrytone dion* W. H. Edwards, and the unique type of *Atrytone dion* race *alabamae* Lindsey (Figs. 9, 10) for comparison with our material, and also to Mr. Ernest L. Bell, of Flushing, N. Y., who most courteously verified our determination of certain skippers.

Family NYMPHALIDAE: Subfamily SATYRINAE: *Enodia creola* (Figs. 1, 2); western border of the Dismal Swamp and westward in wet woods, locally frequent, always with the following. *Enodia portlandia;* locally frequent to abundant in low wet woods throughout Princess Anne, Norfolk, and Nansemond Cos. *Neonympha gemma;* locally common in very wet woods in Princess Anne Co.; less common in Norfolk and Nansemond Cos. *Neonympha areolatus* var. *septentrionalis* (Figs. 3, 4); along Norfolk Southern Railway, about 1½ miles north of the North Carolina line; frequent. *Neonympha sosybius;* common everywhere in woods in Princess Anne, Norfolk, and Nansemond Cos. *Neonympha eurytus;* Bayford, Northampton Co., common in spring (F. Walker). *Cercyonis alope alope;* occasional throughout except in the eastern part of Princess Anne Co., where it is replaced by the following. *Cercyonis alope pegala;* Virginia Beach and Princess Anne; frequent.

Subfamily NYMPHALINAE: *Chlorippe clyton;* Bayford, Northampton Co., sometimes common (F. Walker). *Basilarchia arthemis astyanax;* occasional throughout. *Basilarchia archippus;* occasional throughout. *Junonia coenia;* everywhere common. *Pyrameis atalanta;* not seen in Princess Anne Co., elsewhere occasional to common. *Pyrameis virginiensis;* not seen in Princess Anne Co., elsewhere occasional to frequent. *Pyrameis cardui;* Wachapreague and Locustville, Accomac Co., occasional; Suffolk, occasional; Green Sea, frequent. *Vanessa antiopa;* Bayford, Northampton Co., October (F. Walker). *Polygonia comma;* Bayford, Northampton Co. (F. Walker). *Phyciodes tharos;* common throughout. *Brenthis myrina;* Bayford, Northampton Co., rare (F. Walker). *Argynnis cybele;* Bayford, Northampton Co., rare (F. Walker). *Euptoieta claudia;* occasional or locally frequent throughout.

Subfamily DANAINAE: *Danais plexippus;* occasional throughout but nowhere common.

Subfamily LIBYTHEINAE: *Libythea bachmanni;* Bayford, Northampton Co., one (F. Walker).

Family RIODINIDAE: *Charis virginiensis;* common just south of Virginia Beach.

Family LYCAENIDAE: Subfamily LYCAENINAE: *Chrysophanus phlaeas hypophlaeas;* Wachapreague, Accomac Co., and Jamesville and Kiptopeke, Northampton Co. *Everes comyntas;* generally frequent throughout. *Lycae-*

nopsis argiolus pseudargiolus; not seen in Princess Anne Co., elsewhere locally frequent.

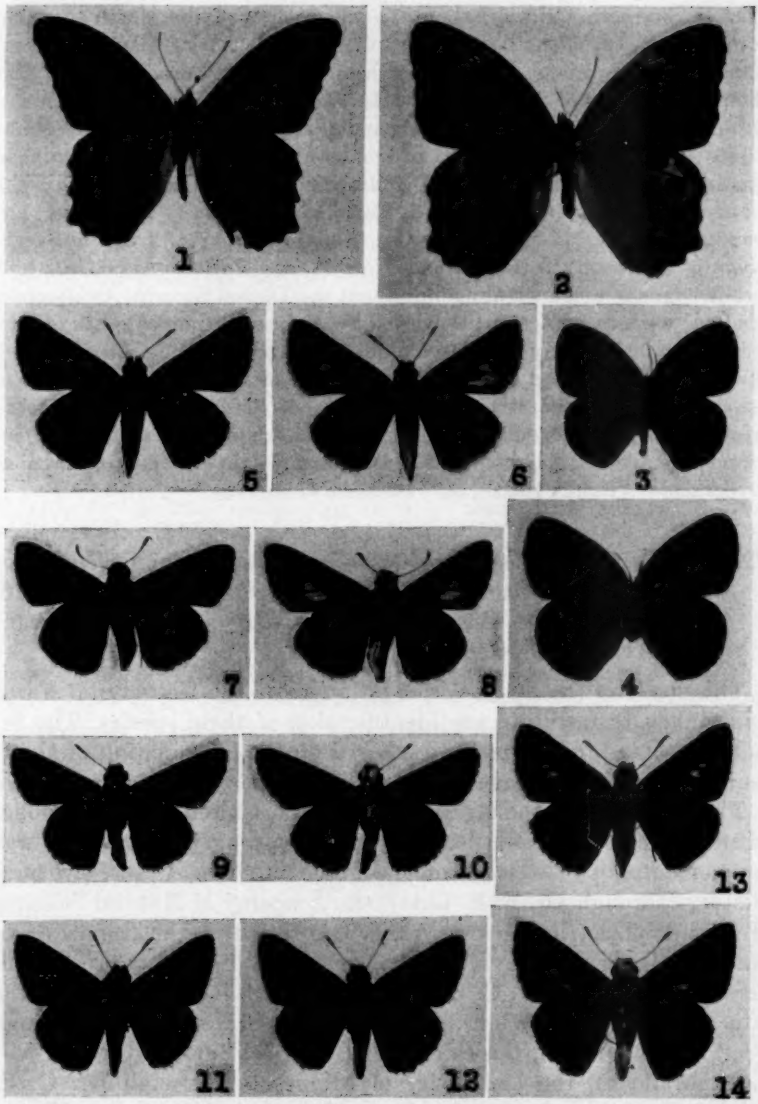
Subfamily THECLINAE: *Atlides halesus;* Lake Drummond, October 27 (P. Bartsch). *Strymon cecrops;* occasional to frequent in woods throughout. *Strymon melinus;* generally frequent throughout. *Mitoura gryneus;* Bayford, Northampton Co.

Family PAPILIONIDAE: Subfamily PIERINAE: *Eurema lisa;* frequent to abundant throughout. *Eurymus philodice philodice;* New Church and Wachapreague, Accomac Co., and Virginia Beach; rare; *Eurymus philodice eurytheme;* abundant everywhere in Accomac and Northampton Cos., infrequent in Princess Anne, Norfolk, and Nansemond Cos. *Zerene caesonia;* Bayford, Northampton Co., one (F. Walker). *Catopsilia eubule;* everywhere frequent in Nansemond, Norfolk, and Princess Anne Cos., becoming abundant near the sea; frequent along the western shore of Northampton and Accomac Cos., and at Chincoteague Island; one female of form *sennae* from Virginia Beach. *Anthocaris genutia;* Bayford, Northampton Co., common in spring (F. Walker). *Pieris rapae;* frequent near farms throughout, though generally not very common.

Subfamily PAPILIONINAE: *Papilio polyxenes asterius;* frequent throughout, and the commonest swallowtail in Accomac and Northampton Cos. *Papilio cresphontes;* frequent at Kiptopeke and Bayford, Northampton Co., and also found at Wachapreague, Accomac Co., and Little Creek and Deep Creek, Norfolk Co. *Papilio glaucus;* not seen in Princess Anne Co., but elsewhere frequent. *Papilio troilus;* frequent throughout; least common in Princess Anne Co. *Papilio palamedes;* the most abundant swallowtail in and near the Dismal Swamp; generally common in suitable situations in Princess Anne, Norfolk, and Nansemond Cos.

Family HESPERIIDAE: Subfamily PYRGINAE: *Goniurus proteus;* Virginia Beach, one. *Epargyreus tityrus;* not seen in Princess Anne Co., occasional to common elsewhere. *Thorybes bathyllus;* occasional throughout. *Thorybes confusis;* Princess Anne, one. *Pyrgus communis;* Wachapreague and Harborton, Accomac Co., and Bayford, Northampton Co. *Pholisora catullus;* not seen in Princess Anne Co., elsewhere locally frequent. *Thanaos juvenalis;* Wachapreague and Dahl Swamp, Accomac Co. *Thanaos horatius;* occasional to frequent throughout. *Thanaos terentius;* Wachapreague and Dahl Swamp, Accomac Co., and Kiptopeke, Northampton Co.

Subfamily HESPERIINAE: *Ancyloxypha numitor;* frequent to common throughout. *Hylephila phylaeus;* occasional to frequent throughout. *Atalopedes campestris;* the commonest skipper in Accomac and Northampton Cos.; occasional in Nansemond Co.; not seen in Norfolk and Princess Anne Cos. *Talides manataaqua;* on the line of the Norfolk Southern Railway, about 1½ miles north of the North Carolina border; frequent. *Talides themistocles;* occasional throughout. *Wallengrenia otho egeremet;* Dahl Swamp and Cashville, Accomac Co.; Bayford, Northampton Co.; on the line of the



Figs. 1, 2.—*Enodia creola*, Dismal Swamp, Va., male, Sept. 1, 1935 (1), and female, Sept. 2, 1935 (2). Figs. 3, 4.—*Neonympha areolatus* var. *septentrionalis*, near the Dismal Swamp, Va., Sept. 3, 1935, male (3) and female (4), under side. Figs. 5, 6.—*Atrytone dion* Edwards, female, type specimen, Whiting, Indiana, upper (5) and under (6) sides. Figs. 7, 8.—*Atrytone dion* Edwards, male, type specimen, Whiting, Indiana, upper (7) and under (8) sides. Figs. 9, 10.—*Atrytone dion* race *alabamae* Lindsey, male, type specimen, from Mobile County, Albama, upper (9) and under (10) sides. Figs. 11, 12.—*Atrytone dion alabamae*, male, Dahl Swamp, Accomac Co., Va., July 23, 1935, upper (11) and under (12) sides. Figs. 13, 14.—*Atrytone dion alabamae*, female, Dahl Swamp, July 25, 1935, upper (13) and under (14) sides.

Norfolk Southern Railway, about 1½ miles north of the North Carolina border. *Poanes zabulon;* Bayford, Northampton Co.; near Adam's Swamp, Nansemond Co., about 1½ miles north of the North Carolina border and about 3 miles west of the Dismal Swamp. *Poanes yehl;* Green Sea, one male; Dismal Swamp, near Suffolk, one female. *Atrytone dion alabamae* (Figs. 11–14); Dahl Swamp, Accomac Co., common; Green Sea, Norfolk Co., one female. *Atrytone ruricola;* Dismal Swamp; Green Sea. *Lerema accius;* the commonest skipper in Nansemond, Norfolk, and Princess Anne Cos.; not seen in Northampton or Accomac Cos. *Amblyscirtes textor;* frequent everywhere in wet woods in Nansemond, Norfolk, and Princess Anne Cos., and locally common and even abundant about the Dismal Swamp. *Amblyscirtes carolina;* western border of the Dismal Swamp about 8 miles south of Suffolk, three, in company with large numbers of the preceding. *Lerodea l'herminier;* western border of Dismal Swamp, frequent: Virginia Beach, one. *Lerodea eufala;* Green Sea, Norfolk Co., one. *Prenes panoquin;* Wachapreague and Chincoteague Island, Accomac Co., abundant on *Borrichia frutescens;* Hack's Neck, Accomac Co.; Bayford, Northampton Co., common. *Prenes ocola;* Virginia Beach, one; Dismal Swamp, one.

ENTOMOLOGY.—*The bees of the genus* Agapostemon (*Hymenoptera: Apoidea*) *occurring in the United States.*[1] GRACE ADELBERT SANDHOUSE, Bureau of Entomology and Plant Quarantine. (Communicated by S. A. ROHWER.)

This study of the *Agapostemon* occurring in the United States was undertaken to facilitate the identification of these species. The results presented in this paper are based on the examination of about four thousand specimens and many dissections of the male genitalia.

The collection of the *Agapostemon* in the United States National Museum has served as a basis for this revisionary study. This was supplemented by loans from the American Museum of Natural History (through Dr. F. E. Lutz), the Academy of Natural Sciences of Philadelphia (through Mr. E. T. Cresson, Jr.), the Illinois State Natural History Survey (through Dr. T. H. Frison), Cornell University (through Dr. J. C. Bradley), McGill University (through the late Mr. Albert F. Winn), South Dakota State College (through Prof. H. C. Severin), the Bureau of Biological Survey (through Mr. J. R. Malloch), the University of Minnesota (through Dr. C. E. Mickel), and the private collections of Drs. Joseph Bequaert, Harold Morrison and T. B. Mitchell, Prof. H. A. Scullen, Mr. C. N. Ainslie

[1] Published by permission of the Chief of the Bureau of Entomology and Plant Quarantine. Received November 8, 1935.

and the late Mr. C. L. Fox (whose collection is now in the California Academy of Sciences).

I have also studied the types in the Academy of Natural Sciences of Philadelphia and wish to take this opportunity to express my appreciation of the courtesies shown me by Mr. E. T. Cresson, Jr., during my visit to that institution. Dr. T. D. A. Cockerell and the late Dr. James Waterston kindly compared specimens with the types of Smith's species in the British Museum. To Mr. E. P. Van Duzee I am indebted for the opportunity of examining certain paratypes from the collection of the California Academy of Sciences.

Genus AGAPOSTEMON Guerin

Agapostemon Guerin, Iconog. Regne Animal de G. Cuvier, Insects **3**: 448. 1844. Genotype, *Apis* (*Andrena*) *femoralis* Guerin. (Monobasic)

Agapostemon F. Smith, Cat. Hymen. Ins. Brit. Mus. **1**: 85–86, pl. 4, figs. 1–4. 1853.—Provancher, Natur. Canad. **13**: 203. 1882.—Petite Faune Ent. Canad., Hymen., p. 703. 1883.—Robertson, Trans. Acad. Sci. St. Louis **7**: 325. 1897.—Crawford, Proc. Nebr. Acad. Sci. **7**: 159. 1901.

HALICTI INTERMEDII, Groupe *Agapostemon* Vachal, Misc. Ent. **11**: 89. 1903. —**19**: 12. 1911.

The name *Agapostemon* was proposed by Guerin in 1844 for a subgenus of *Apis* with *Apis* (*Andrena*) *femoralis* Guerin the only species included, although he mentioned having seen other species with the characters which he uses to define the subgenus. His definition is as follows: "*Nous connaissons plusieurs espèces a cuisses ainsi renflees. Ce sont des males. Peut-etre jugera-t-on a propos de les reunir en un sous-genre, que nous proposerions de nomer Agapostemon. Il serait aux Andrenes ce qu'est le genre Nomia parmi les Halictes.*" Frederick Smith (1853) was the first to give *Agapostemon* generic rank, in this being followed by Cresson, Robertson, Dalla Torre, Cockerell and Crawford; he included in it seven species, four of which were described as new. His discussion of generic characters was based chiefly on those of the head, especially of the trophi. Vachal (1903) treated *Agapostemon* as a group or subgenus of *Halictus* (*Halicti agapostemones*).

This genus can be separated from the other genera of the Halictinae represented in the nearctic fauna by the length of the posterior tibia, which is as long as, or longer than, the combined length of the tarsal joints, while in the others it approximates more nearly that of the metatarsus alone. The sexual dimorphism is so great that some characters will have to be given separately for each sex. The characters of the genus as here limited are as follows:

Head, when viewed from the front, appearing rounded except where the clypeus extends below the lower margins of the eyes. Eyes large and bare, forming the lateral boundaries of the head for most of its length; their inner margins quite strongly emarginate. Front foveolate-punctate, when viewed laterally, level with the eyes, occupying about one-half the space from vertex

to apex of clypeus. Clypeus and postclypeus of equal length, strongly convex, with well-separated punctures; clypeus extending at least half its length below the lower margins of the eyes; apical margin truncate. Gena (malar space) very short. Postgenae declivous behind the eyes, striate-punctate. Labrum of female with basal portion as wide as truncate apex of clypeus, sides nearly parallel; apical portion about one-third as wide as basal, sides converging toward apex and fringed with curved bristles; labrum of male nearly triangular, sides slightly convex, basal portion with transverse elevation. Mandible of female strongly curved, apically bidentate, inferior tooth much larger and extending beyond superior; mandible of male edentate, narrowing gradually to pointed apex. Antennae inserted about half way between apical margin of clypeus and postocellar line; scape of female a little more than one-third length of antenna, scape of male about as long as joints two to four.

General contour of thorax more regular than that of honeybee (see Snodgrass, *Anatomy and physiology of the honeybee*, fig. 231, 1925.), that of female more robust than that of male. Prothorax showing no striking modifications; posterior margin of prothoracic lobe heavily fringed with hair. Mesoscutum of male with uniform, nearly contiguous punctures, varying little among the species; that of female closely uniformly punctate or with punctures of two distinct sizes, the punctation specifically distinct. Metatergum irregularly foveolate. Mesopleura foveolate. Metapleura of female with somewhat irregular, but principally horizontal low carinae, of male foveolate. Propodeum extending caudad to a distance about equal to length of metatergum and thence abruptly declivous to attachment of abdomen; posterior surface irregularly carinate, enclosed by a sharply defined carina, more strongly developed in female; dorsal surface lacking the somewhat crescentic disk or enclosed space found in many of the other halictine bees; sculpturing consisting of low carinae variously arranged; lateral surfaces with nearly horizontal low carinae, between them rows of small but deep punctures. Tegula smooth, ovoid, about same color as basal wing-veins. Wings varying little from those of related genera and little within the genus; hyaline, slightly yellowish infumate, usually slightly darker apically; second cubital cell of male distinctly narrower.

Legs of female and front and middle legs of male not varying in structure within the genus; hind legs of male showing greatest modification and varying with the species. In hind leg of female, posterior surface of femur with a single row of very long and strongly curled branched hairs; anterior surface with several rows of shorter branched hairs; hind tibia with knee-plate obsolescent, posterior margin with long simple hairs, anterior margin with variously branched hairs; inner calcar pectinate, usually with from three to five broad spatulate teeth. Hind leg of male with femur usually thickened, distinctly wider than trochanter and toothed below near apex; tibia broader than metatarsus; metatarsus frequently enlarged and toothed; first and second joints of tarsus coalescent.

Abdomen of female broadly ovoid, length as ordinarily extended about twice its width at apex of second tergite; tergites finely and uniformly punctured; fifth tergite with median rima, laterally densely pubescent; sixth tergite with well-defined pygidial area; second to fifth with basal fasciae of pale appressed hair. Abdomen of male more slender and frequently curved downward at apex; seven tergites, but only six sternites exposed; tergites uniformly punctured and pubescent, seventh with a distinct polished oval pygidial area bounded apically and laterally by a carina; sternites one to

six varying little within the genus, seventh and eighth very small and lying against ventral surface of basal ring, with slight specific differences.

In both sexes head and thorax brilliant blue-green (as in *Chrysis*); abdominal tergites of female concolorous with thorax, or black or brown, tergites of male transversely banded black and yellow, the black sometimes obscurely tinged with blue-green. Legs of female brown or yellowish brown, of male yellow variously marked with black.

The genitalia of the male are specifically distinct and a study of them has assisted greatly in determining the amount of variation within the species. Since the paper by Beck (Proc. Utah Acad. Sci. 10: 89–137, pls. I–VII. 1933) gives the results of rather extensive studies in homologies of parts of the male genitalia of bees, his terminology was used in labeling these parts. For a description of the genitalia of a species of *Agapostemon*, see page 109 and plate VII, figures 168–169 of his paper. In the present paper dorsal and ventral views of the entire genitalia are given for *Agapostemon virescens* (Fabricius), since they approach most nearly those of the genotype, *femoralis* (Guerin), and for each species a dorsal and slightly caudal view of only the distal portion of the coxopodite and stylus, since they present the greatest specific differences.

KEY TO THE SPECIES OF AGAPOSTEMON OCCURRING IN THE UNITED STATES

1. Females.....2
   Males.....10
2. Abdominal tergites not concolorous with the thorax, but black, brown or testaceous.....3
   Abdominal tergites concolorous with the thorax, brilliant green or blue-green.....6
3. Apex of clypeus black. Abdominal tergites entirely black; base of first tergite with lateral patches of white hair; hair on apices of tergites black. Posterior surface of propodeum with oblique carinae. Front and middle legs dark brown. Tegular and wing-veins brown-testaceous.....4
   Apex of clypeus yellow, or black and yellow. Abdominal tergites testaceous, brown, or, if nearly black, always tinged with brown or blue-green, especially apically; base of first tergite with a wide band of dense white hair; hair on apices of tergites white, except on the fifth, where it is yellowish or brownish. Posterior surface of propodeum irregularly carinate. Front and middle legs largely or partly yellow. Tegula and wing-veins yellow-testaceous.....5
4. Base of mandible yellow. Postgenae laterad of the hypostomal carinae with several moderately coarse striae. Hair on posterior legs strongly infuscated. Head and thorax brilliant green, usually not at all bluish. Carinae on dorsal surface of propodeum not forming a median triangle. Punctures on abdominal tergites separated by twice the diameter of a puncture. Species smaller, 11 to 12 mm. long.....
   .....*virescens* (Fabricius)

Base of mandible reddish black. Postgenae laterad of hypostomal carinae very finely striate. Hair on posterior legs yellowish white. Head and thorax green, usually strongly tinged with blue. Carinae on dorsal surface of propodeum forming a median triangle. Punctures on abdominal tergites separated by the diameter of a puncture. Species larger, 14 to 15 mm. long..... *coloradinus* (Vachal)

5. Scape largely yellow. Femora and abdomen testaceous. Yellow of clypeus extending upwards in the middle to form a triangle; apical margin yellow..... *melliventris* Cresson

Scape dark brown. Femora and abdomen dark brown, the apex of the latter faintly tinged with blue-green. Yellow of clypeus not extending upwards in the middle; apical margin black..... ..... *melliventris* var. *plurifasciatus* (Vachal)

6. Mesoscutum with punctures nearly uniform in size and nearly contiguous 7

Mesoscutum with well-separated punctures of two distinct sizes....9

7. Mesoscutum not at all rugose between punctures, more finely and uniformly punctured. Abdominal tergites appearing dull, with punctures separated by less than their diameter. Dorsal surface of propodeum dull, with irregularly anastomosing carinae. Pubescence strongly tinged with ochreous. Wings dusky, especially at the apices ..... *splendens* (Lepeletier)

Mesoscutum rugose between punctures, more coarsely punctured, foveolate-punctate on the anterior and lateral portions. Abdominal tergites shining between punctures, which are separated by more than their diameter. Dorsal surface of propodeum shining, with longitudinal carinae. Pubescence and wings paler.....8

8. Species larger, usually about 12 to 13 mm. long; blue-green. Pubescence white. Sixth abdominal tergite with hair on the basal third entirely pale..... *cockerelli* Crawford.

Species smaller, usually less than 10 mm. long; green, not at all bluish. Pubescence distinctly yellowish. Sixth abdominal tergite with hair fuscous, except for a small patch of yellowish hair at each side; no pale hair on the median basal portion..... *radiatus* (Say)

9. Smaller punctures of mesoscutum usually separated by about their diameter. Dorsal surface of propodeum irregularly carinate, usually with a distinct median triangular area. Species larger, about 12 mm. long. Pubescence slightly tinged with yellow..... *texanus* Cresson

Smaller punctures of mesoscutum usually separated by at least twice their diameter. Dorsal surface of propodeum with longitudinal carinae. Species smaller, about 10 mm. long. Pubescence pure white.. ..... *angelicus* Cockerell

10. Base of first abdominal tergite usually of a brownish tint, but never distinctly black; dark bands on the intermediate tergites scarcely

one-third the length of a tergite. Legs distad of the trochanters pale, except for a brownish spot at the apex of the hind femur and one at base of hind tibia; hind femur hardly wider than the trochanter, the tooth near the apex weakly developed. Wings clear testaceous....11

Base of first abdominal tergite black; dark bands on the intermediate tergites fully one-half the length of a tergite. Legs distad of the trochanters conspicuously marked with black; hind femur distinctly wider than trochanter, the tooth near the apex strongly developed. Wings quite strongly infumated.....12

11. Trochanters of front and middle legs yellow, of the hind legs tinged with green. Scape entirely yellow, or with a small brownish dot on upper side near the apex. Dark bands on the abdominal tergites not reaching the lateral margins.....*melliventris* Cresson

Trochanters of all the legs green. Scape with the upper side brown. Dark bands on the abdominal tergites reaching the lateral margins.. .....*melliventris* var. *plurifasciatus* (Vachal)

12. Dark bands on the abdominal tergites strongly tinged with metallic blue-green, which is especially conspicuous laterally on the apical segments.....13

Dark bands on the abdominal tergites dull black, with no metallic tints.....14

13. Species larger, 11 to 12 mm. long, usually more yellowish green, with pubescence slightly yellowish. Dorsal surface of propodeum with a distinct triangle in the middle. Front and middle trochanters with varying amounts of black and yellow; if largely black, then there are marks of black on the bases of the femora; hind tibia always with a long black mark on the anterior surface, often also with one on the posterior surface.....*texanus* Cresson

Species smaller, about 9 mm. long, usually more bluish green, with pubescence pure white. Dorsal surface of propodeum without a median triangle, the carinae coarser. All the trochanters black, but no black on the bases of the femora; hind tibia with a long black mark on the posterior surface, but never with one on the anterior surface .....*angelicus* Cockerell

14. Hind femur swollen so strongly that its width is distinctly more than one-half of its length.....15

Hind femur not so strongly swollen, its width less than one-third of its length.....16

15. Black bands on the abdominal tergites occupying more than half of their length; fifth and sixth abdominal sternites largely black. Hind femur a little more than one-half as wide as long. Dorsal surface of propodeum dull, with irregularly anastomosing carinae. Wings dusky .....*splendens* (Lepeletier)

Black bands on the abdominal tergites occupying less than half of

their length; basal two-thirds of fifth sternite and most of sixth yellow. Hind femur about three-fourths as wide as long. Dorsal surface of propodeum more polished, with carinae on the entire length on the middle and laterally on the basal fourth principally longitudinal. Wings clear hyaline.....*cockerelli* Crawford

16. Species smaller, about 9 mm. long or less. Dorsal surface of propodeum with longitudinal carinae. Punctures of mesoscutum contiguous, giving a dull, almost velvety appearance. Abdominal sternites more than half yellow; apical margin of the fourth with a median green spot, laterally with two stout bristles on each side. Front and middle trochanters largely yellow; bases of femora yellow..*radiatus* (Say)

Species larger, about 11 mm. long. Dorsal surface of propodeum with irregularly anastomosing carinae. Punctures of mesoscutum more widely separated, the interspaces shining. Abdominal sternites largely black; apical margin of the fourth lacking the green spot in the middle between the lateral bristles. All the trochanters black; bases of femora strongly marked with black.....17

17. Black markings on the posterior surfaces of the front and middle femora confined to the basal halves, of the hind femur to the apical third; posterior surface of the hind tibia yellow, except for a small black spot near the apex; front and middle tibiae with basal spots of black. Abdominal tergites with much black hair apically. Second and third sternites with hair quite sparse; sixth with a low median carina. Head and thorax brilliant green, usually not at all bluish. Carinae on the dorsal surface of the propodeum not forming a median triangular area.....*virescens* (Fabricius)

Black markings on the posterior surfaces of all the femora and tibiae extending nearly the length of the surfaces. Abdominal tergites with hair largely white. Second and third sternites with conspicuous apical fringes of white hair; sixth without a median carina. Head and thorax distinctly bluish green. Carinae on dorsal surface of propodeum forming a median triangle.....*coloradinus* (Vachal)

Agapostemon virescens (Fabricius)

Andrena virescens Fabricius, Syst. Ent., p. 378, n. 12. 1775.—Spec. Insect. 1: 474, n. 16. 1781.—Mant. Insect. 1: 299, n. 18. 1787.—Olivier, Encycl. Method. Ins.; Hist. Nat. Ins. 1: 137, n. 23. 1789.—Fabricius, Ent. Syst. 2: 314, n. 28. 1798.

Apis (*Andrena*) *virescens* Gmelin, Linné, Syst. Nat., Ed. 13a, 1 (pt. 5): 2792, n. 185. 1790.

Apis virescens Christ, Natur. d. Insect., p. 154. 1791.

Andrena nigricornis Fabricius, Ent. Syst. 2: 313, n. 28. 1793.—Coquebert, Illustr. Iconogr. Ins. 2: 63, T. 15, fig. 7. 1801.

Megilla virescens Fabricius, Syst. Piez., p. 333, n. 23. 1804.

Centris nigricornis Fabricius, Syst. Piez., p. 360, n. 33. 1804.

Hylaeus nigricornis Klug, Magaz. f. Insectenk. 6: 222. 1807.—Magaz. Ges. naturf. Fr. Berlin 2: 57, n. 85. 1808.

Halictus nigricornis Say, Boston Jour. Nat. Hist. **1**: 394, n. 1. 1837.—Leconte, Writ. Thomas Say **2**: 772, n. 1. 1859.
Halictus dimidiatus Lepeletier, Hist. Nat. Ins. **2**: 283, n. 24. 1841.
Agapostemon nigricornis Smith, Cat. Hymen. Ins. Brit. Mus. **1**: 86, n. 1. 1853.—Cresson, Trans. Amer. Ent. Soc. suppl., p. 293. 1887.
?*Agapostemon tricolor* Provancher (not Lepeletier), Natur. Canad. **13**: 203. 1882.—Petite Faun. Ent. Canad. Hymen., p. 703. 1883.
Augochlora radiata Provancher, Natur. Canad. **13**: 205. 1882.—Petite Faun. Ent. Canad. Hymen., p. 705. 1883.—Dalla Torre, Cat. Hymen. **10**: 96 (in part). 1896.
Apis viridula Cresson (not Fabricius), Trans. Amer. Ent. Soc., suppl., p. 309. 1887.
Agapostemon bicolor Robertson, Trans. Amer. Ent. Soc. **20**: 148. 1893.—Dalla Torre Cat. Hymen. **10**: 97. 1896.
Agapostemon viridula Robertson (not Fabricius), Trans. Amer. Ent. Soc. **22**: 118. 1895.
Agapostemon virescens Dalla Torre, Cat. Hymen. **10**: 98 (in part). 1896.—Cockerell, Ann. Mag. Nat. Hist. (9) **8**: 363. 1921.
Agapostemon viridulus Robertson, Trans. Acad. Sci. St. Louis **7**: 325. 1897.—Crawford, Proc. Nebr. Acad. Sci. **7**: 173. 1901.
Halictus (*Agapostemon*) *viridulus* Vachal, Misc. Ent. **11**: 90, 101. 1903.
Halictus (*Agapostemon*) *virescens* Viereck, Conn. State Geol. & Nat. Hist. Survey Bull. **22** (pt. 3): 704.

Type.—Female, in the Banksian Collection at the British Museum, where it was seen by Cockerell in 1921 and the identity of the species confirmed. The present locations of the types of *nigricornis* and of *dimidiatus* are unknown to the writer. The types of *bicolor* are in Robertson's collection.

Distribution.—Insofar as is known, distributed throughout the United States from coast to coast north of 40 degrees latitude, extending down the Mississippi Valley and eastern slope of the Rocky Mountains to Louisiana and Texas. About 700 specimens have been examined from the following states: Maine, New Hampshire, Vermont, Massachusetts, Connecticut, New York, New Jersey, Pennsylvania, Maryland, Virginia, District of Columbia, North Carolina, Alabama, Kentucky, Tennessee, Ohio, Michigan, Indiana, Illinois, Iowa, Minnesota, Missouri, Louisiana, Texas, Colorado, Kansas, Nebraska, North Dakota, South Dakota, Montana, Wyoming, Idaho, Oregon, and Washington.

Of the nearctic species, *virescens* and the closely related *coloradinus* are nearest to the genotype, *femoralis*. *Virescens* can be separated from *coloradinus* by the characters given in the key. The male is readily distinguished by the median carina on the sixth sternite. The female is the only one having a black abdomen which is widely distributed throughout the United States.

Agapostemon coloradinus (Vachal), n. comb.

Agapostemon coloradensis Crawford, Proc. Nebr. Acad. Sci. **7**: 163. 1901.—Cockerell, Ann. Mag. Nat. Hist. (7) **19**: 532. 1907.
Halictus (*Agapostemon*) *coloradinus* Vachal, Misc. Ent. **11**: 90. 1903. (Proposed for *Halictus* (*Agapostemon*) *coloradensis* Crawford, not *Halictus* (*Augochlora*) *coloradensis* Titus.)

Agapostemon tyleri Cockerell, Ann. Mag. Nat. Hist. (8) **20:** 241. 1917 (new synonymy).

Agapostemon martini Cockerell, Pan-Pacific Ent. **3:** 153, female only. 1927 (new synonymy).

Type.—Female (lectotype selected by Crawford), southern Colorado, in the collection of the United States National Museum. The specimen on which Cockerell based the description of the male of *coloradinus* and the type and "cotype" (allotype) of *tyleri* are also in this collection. The type of *martini* is in the collection of the California Academy of Sciences.

Distribution.—Apparently limited to the southern Rocky Mountain region from South Dakota and Colorado to western Texas, southern Arizona and Mexico. Only 38 specimens have been seen from the following states: Texas, Colorado, Nebraska, South Dakota, Utah and New Mexico; also from Mexico.

This species is closely related to *virescens* and apparently replaces it in the southwestern part of the United States. The type of *martini* was not seen, but the description of the female agrees well with the type of *coloradinus*. Both sexes of *tyleri* have been compared with *coloradinus* and found to be identical.

Agapostemon melliventris Cresson

Agapostemon melliventris Cresson, Trans. Amer. Ent. Soc. **5:** 101. 1874.—Rept. Geogr. & Geol. Explor. & Surv. 100th Merid. **5:** 721, pl. 33, fig. 4. 1875.—Trans. Amer. Ent. Soc., suppl. p. 293. 1887.—Dalla Torre, Cat. Hymen. **10:** 97. 1896.—Cockerell, Trans. Amer. Ent. Soc. **24:** 146. 1897. —Crawford, Proc. Nebr. Acad. Sci. **7:** 164. 1901.

Agapostemon digueti Cockerell, Proc. Calif. Acad. Sci. **12:** 539. 1924 (new synonymy).

Type.—Female, lectotype, Nevada, in the collection of the Academy of Natural Sciences, Philadelphia. The types of *digueti* are in the collection of the California Academy of Sciences. The synonymy of *digueti* is based upon a study of paratypes of both sexes in the collection of the United States National Museum.

Distribution.—Apparently limited to the extreme southwestern part of the United States and northern Mexico. In the United States extending from southern Texas to southern California and north to Utah and Oklahoma. The variety *plurifasciatus* replaces the typical form in northeastern Colorado northwestern Kansas and Nebraska. About 400 specimens have been examined from the following states: Texas, Oklahoma, Colorado, Nebraska, Utah, New Mexico, Arizona and California; also from Lower California and Mexico.

Agapostemon melliventris var. **plurifasciatus** (Vachal), n. comb.

Agapostemon fasciatus Crawford, Proc. Nebr. Acad. Sci. **7:** 163. 1901.

Halictus (*Agapostemon*) *plurifasciatus* Vachal, Misc. Ent. **11:** 93, 101. 1903. (Proposed for *Halictus* (*Agapostemon*) *fasciatus* Crawford, not *Halictus fasciatus* Nylander.)

Type.—Female and allotype, male (lectotypes selected by Crawford), from Lincoln, Nebraska, in the collection of the United States National Museum.

Distribution.—I have seen specimens of this variety only from Lincoln, Nebraska; Sterling, Colorado; and Clay County, Kansas.

This differs from *melliventris* only in color as given in the key. Since no morphological differences could be found, *plurifasciatus* is considered to be a color variety of *melliventris.*

Agapostemon splendens (Lepeletier)

Halictus splendens Lepeletier, Hist. Nat. Ins. Hymen. **2:** 283, n. 25. 1841.—Cresson, Trans. Amer. Ent. Soc., suppl., p. 293. 1887.—Dalla Torre, Cat. Hymen. **10:** 85. 1896.

Agapostemon aeruginosus Smith, Cat. Hymen. Ins. Brit. Mus. **1:** 86, n. 3. 1853.—Cresson, Trans. Amer. Ent. Soc., suppl., p. 293. 1887.—Dalla Torre, Cat. Hymen. **10:** 97. 1896.

Agapostemon nigricornis Robertson (not Fabricius), Trans. Amer. Ent. Soc. **20:** 147. 1893.—Dalla Torre, Cat. Hymen. **10:** 97. 1896.

Agapostemon splendens Robertson, Trans. Acad. Sci. St. Louis **7:** 328. 1897.—Crawford, Proc. Nebr. Acad. Sci. **7:** 161. 1901.—Howard, Insect Book, pl. 3, fig. 14. 1905.—Graenicher, Ann. Ent. Soc. Amer. **23:** 158, 168. 1930.

Halictus (*Agapostemon*) *aeruginosus* Vachal, Misc. Ent. **11:** 95. 1903.

Halictus (*Agapostemon*) *splendens* Vachal, Misc. Ent. **11:** 95. 1903.

Halictus (*Agapostmeon*) *nigricornis* Vachal, Misc. Ent. **11:** 100. 1903.

Type.—Female. "Carolina." The present location of the type is unknown to the writer. The type of *aeruginosus* is in the British Museum where it was compared by Cockerell and Waterston with specimens of *splendens* and the synonymy confirmed.

Distribution.—Insofar as is known, distributed throughout the eastern and central United States from southern New Hampshire to southern Florida and west to Texas and eastern Colorado. No specimens have been seen from north of the 45th degree of latitude nor west of the 105th meridian. Over 300 specimens have been examined from the following states: New Hampshire, Massachusetts, Connecticut, New York, New Jersey, Maryland, Virginia, North Carolina, Georgia, Florida, Alabama, Michigan, Indiana, Illinois, Iowa, Minnesota, Missouri, Arkansas, Louisiana, Texas, Oklahoma, Colorado, Kansas, Nebraska, and Arizona.

Agapostemon cockerelli Crawford

Agapostemon cockerelli Crawford, Proc. Nebr. Acad. Sci. **7:** 161. 1901.——Cockerell, Pan-Pacific Ent. **3:** 155, female only. 1927.

Agapostemon femoratus Crawford, Proc. Nebr. Acad. Sci. **7:** 162. 1901.—Cockerell, Pan-Pacific Ent. **3:** 157. 1927 (new synonymy).

Agapostemon radiatus Cockerell (not Say), Ent. News **9:** 27. 1898 (new synonymy).

Agapostemon californicus Crawford, Proc. Nebr. Acad. Sci. **7:** 164, female only. 1901 (new synonymy).

Agapostemon pulcher Robertson (not Smith), Canad. Ent. **34**: 49. 1902 (new synonymy).
? *Nomia cillaba* Cameron, Trans. Amer. Ent. Soc. **28**: 376. 1902 (new synonymy).
Halictus (*Agapostemon*) ? *pulcher* Vachal, Misc. Ent. **11**: 94. 1903.
? *Halictus* (*Agapostemon*) *cockerelli* Vachal, Misc. Ent. **11**: 95. 1903.
Halictus (*Agapostemon*) *femoratus* Vachal, Misc. Ent. **11**: 100. 1903.
? *Agapostemon cillaba* Cockerell, Ann. Mag. Nat. Hist. (8), **4**: 311. 1909.
Agapostemon martini Cockerell, Pan-Pacific Ent. **3**: 153, male only. 1927. (new synonymy).

Type.—Female, holotype, from Mesilla Park, New Mexico, in the collection of the United States National Museum. The type (lectotype, selected by Crawford) of *femoratus* from Moscow, Idaho, and a paratype of *martini* are also in this collection. The type of *cillaba* is in the British Museum. The allotype ("cotype") of *martini* is in the collection of the California Academy of Sciences. Cockerell's designation (1927) of a *type locality* for *femoratus* cannot be considered as a true type fixation, as it was based upon a selection of a locality from literature and not from a study of any of the type series.

Distribution.—Insofar as is known, distributed throughout the western part of North America, west of the 100th meridian, from British Columbia to Mexico. It apparently replaces *radiatus* in the west. Over 300 specimens have been examined from the following states: Texas, Colorado, North Dakota, Montana, Wyoming, Idaho, Utah, New Mexico, Arizona, California, Nevada, and Washington. Material was also seen from Alberta and British Columbia, Canada, and from Mexico.

Agapostemon radiatus (Say)

Halictus radiatus Say, Boston Jour. Nat. Hist. **1**: 394, n. 2. 1837.—Leconte, Writ. Thomas Say **2**: 772, n. 2. 1859.
Halictus tricolor Lepeletier, Hist. Nat. Ins. Hymen. **2**: 289, n. 33. 1841.
Augochlora radiata Smith, Cat. Hymen. Ins. Brit. Mus. **1**: 80, n. 22. 1853.—Dalla Torre, Cat. Hymen. **10**: 96, in part. 1896.
? *Agapostemon tricolor* Smith, Cat. Hymen. Ins. Brit. Mus. **1**: 86, n. 2. 1853.
Agapostemon pulchra Smith, Cat. Hymen. Ins. Brit. Mus. **1**: 87, n. 4. 1853. —Cresson, Trans. Amer. Ent. Soc. suppl., p. 293. 1887.
Agapostemon radiatus Cresson, Trans. Amer. Ent. Soc. suppl., p. 293. 1887. —Robertson, Trans. Amer. Ent. Soc. **20**: 147, in part. 1893.—Dalla Torre, Cat. Hymen. **10**: 97. 1896.—Robertson, Trans. Acad. Sci. St. Louis **7**: 327. 1897.—Crawford, Proc. Nebr. Acad. Sci. **7**: 163, in part. 1901.—Howard, Insect Book, pl. 3, fig. 11. 1905.—Lutz, Fieldbook of Insects, pl. xciv. 1918 (1st ed.), 1921 (2d. ed.).
Agapostemon tricolor Robertson, Trans. Amer. Ent. Soc. **20**: 148. 1893.
Agapostemon pulcher Dalla Torre, Cat. Hymen. **10**: 97. 1896.
Halictus (*Agapostemon*) *radiatus* Vachal, Misc. Ent. **11**: 95, 102, 104. 1903.
?*Halictus* (*Agapostemon*) *cockerelli* Vachal, Misc. Ent. **11**: 94. 1903.
Agapostemon sulcatulus Cockerell, Ann. Mag. Nat. Hist. (8), **4**: 25. 1909 (new synonymy).

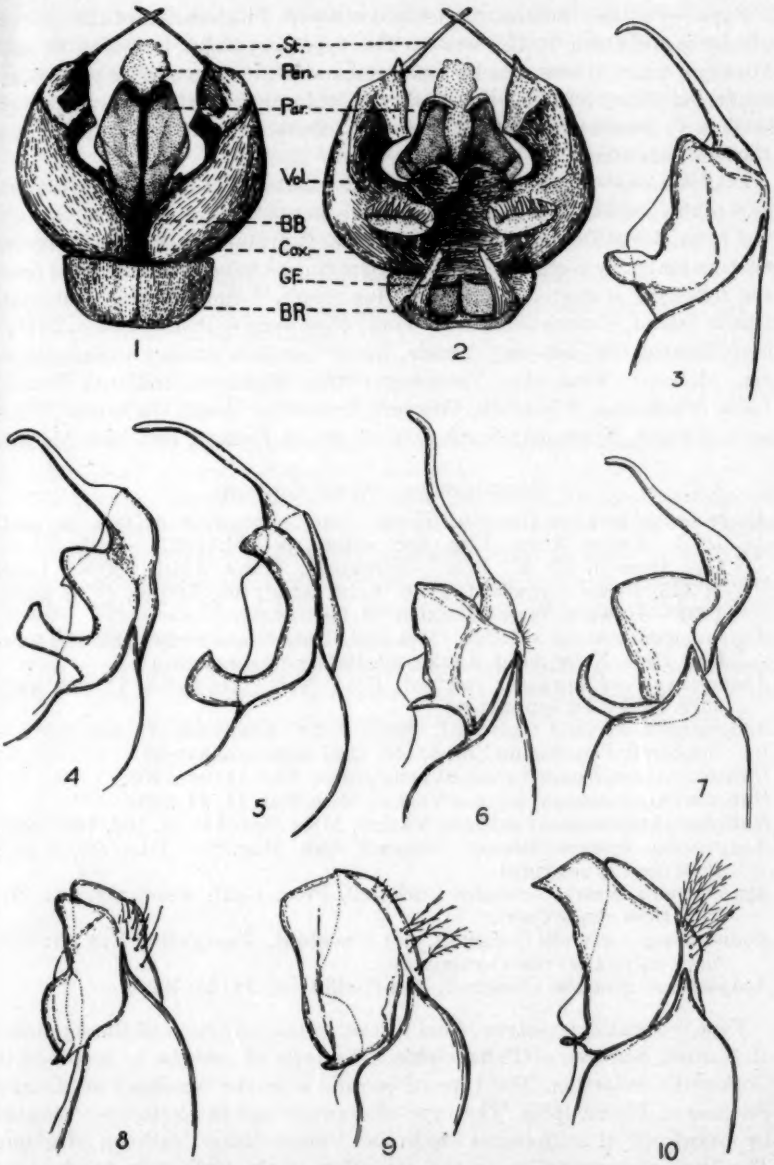


Fig. 1.—*Agapostemon virescens* (Fabricius). Male genitalia, dorsal view. Fig. 2.—*A. virescens*. Male genitalia, ventral view. BR, Basal Ring; BB, Basal Bridge; GF, Genital Foramen; Cox., Coxopodite; St., Stylus; Vol., Volsella; Par., Paramere; Pen., Penis. Fig. 3.—*A. virescens*. Distal portion of coxopodite, dorsal view. Fig. 4.—*A. angelicus* Cockerell. Distal portion of coxopodite, dorsal view. Fig. 5.—*A. splendens* (Lepeletier). Distal portion of coxopodite, dorsal view. Fig. 6.—*A. coloradius* (Vachal). Distal portion of coxopodite, dorsal view. Fig. 7.—*A. texanus* Cresson. Distal portion of coxopodite, dorsal view. Fig. 8.—*A. melliventris* Cresson. Distal portion of coxopodite, dorsal view. Fig. 9.—*A. radiatus* (Say). Distal portion of coxopodite, dorsal view. Fig. 10.—*A. cockerelli* Crawford. Distal portion of coxopodite, dorsal view. The illustrations were made by Mrs. Eleanor A. Carlin of the Bureau of Entomology and Plant Quarantine.

Type.—Female, Indiana, probably destroyed. The location of the type of *tricolor* is unknown to the writer. The type of *pulchra* is in the British Museum, where it was seen by Cockerell and Waterston and its synonymy confirmed. They felt that the locality "California" on the type of *pulchra* must have been erroneous. The type of *sulcatulus* is in the United States National Museum.

Distribution.—Insofar as is known, distributed throughout the eastern part of the United States, east of the 105th meridian, from Maine to Georgia and from North Dakota to northern Texas. It is apparently replaced in the western states by *cockerelli*. About 650 specimens have been examined from the following states: Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Maryland, District of Columbia, Virginia, North Carolina, South Carolina, Georgia, Alabama, Kentucky, Tennessee, Ohio, Michigan, Indiana, Illinois, Iowa, Minnesota, Wisconsin, Missouri, Louisiana, Texas, Oklahoma, Colorado, Kansas, Nebraska, North Dakota, South Dakota, and New Mexico.

Agapostemon texanus Cresson

Agapostemon texanus Cresson, Trans. Amer. Ent. Soc. **4**: 255, in part. 1872.—Trans. Amer. Eng. Soc. suppl., p. 293. 1887.—Dalla Torre, Cat. Hymen. **10**: 97. 1896.—Robertson, Trans. Acad. Sci. St. Louis **7**: 325. 1897.—Crawford, Proc. Nebr. Acad. Sci. **7**: 160, (? in part). 1901.—Howard, Insect Book, pl. 14, fig. 2. 1905.

Agapostemon texanus subtilior Cockerell, Ent. News **9**: 27. 1898.—Crawford, Proc. Nebr. Acad. Sci. **7**: 160. 1901 (new synonymy).

Agapostemon californicus Crawford, Proc. Nebr. Acad. Sci. **7**: 164, male only. 1901 (new synonymy).

Agapostemon borealis Crawford, Proc. Nebr. Acad. Sci. **7**: 160. 1901.—Cockerell, Pan-Pacific Ent. **3**: 156. 1927 (new synonymy).

Halictus (*Agapostemon*) *borealis* Vachal, Misc. Ent. **11**: 94. 1903.

Halictus (*Agapostemon*) *texanus* Vachal, Misc. Ent. **11**: 94. 1903.

Halictus (*Agapostemon*) *subtilior* Vachal, Misc. Ent. **11**: 95, 102, 104. 1903.

Agapostemon texanus iowensis Cockerell, Ann. Mag. Nat. Hist. (8), **5**: 363. 1910 (new synonymy).

Agapostemon texanus vandykei Cockerell, Proc. Calif. Acad. Sci. **14**: 191. 1925 (new synonymy).

Agapostemon cockerelli Cockerell, not Crawford, Pan-Pacific Ent., **3**: 155, male only. 1927 (new synonymy).

Agapostemon vandykei Cockerell, Pan-Pacific Ent. **3**: 155. 1927.

Type.—Female, lectotype, from Texas, in the collection of the Academy of Natural Sciences of Philadelphia. The type of *subtilior* is probably in Cockerell's collection. The type of *borealis* is in the Academy of Natural Sciences of Philadelphia. The type of *iowensis* and the lectotype (selected by Crawford) of *californicus* are in the United States National Museum. The type of *vandykei* is in the collection of the California Academy of Sciences.

Distribution.—Insofar as is known, distributed throughout the United

States from coast to coast north of the 40th degree of latitude, extending southward along the Appalachian Mountains to North Carolina, along the Rocky Mountains to southern Texas and Mexico, and along the Pacific Coast Ranges to southern California. About 1000 specimens have been examined from the following states: New Hampshire, Connecticut, New York, Pennsylvania, North Carolina, Michigan, Indiana, Illinois, Iowa, Minnesota, Wisconsin, Louisiana, Texas, Oklahoma, Colorado, Kansas, Nebraska, North Dakota, South Dakota, Montana, Wyoming, Idaho, Utah, New Mexico, Arizona, California, Oregon, Nevada, and Washington.

Agapostemon angelicus Cockerell

Agapostemon angelicus Cockerell, Proc. Calif. Acad. Sci. 12: 537. 1924.—Pan-Pacific Ent. 3: 156. 1927.

Agapostemon texanus Cresson, Trans. Amer. Ent. Soc. 4: 255, in part. 1872.—? Authors, in part (new synonymy).

Halictus (*Agapostemon*) *texanus* Vachal, Misc. Ent. 11: 94, ? in part. 1903.

Type.—Female, Pond Island, Bay, Angel de la Guarda Island, in the collection of the California Academy of Sciences.

Distribution.—Apparently limited to the southern Rocky Mountain region from southern Texas to North Dakota and Idaho and along the Pacific Coast from southern California to the 40th degree of latitude. Over 400 specimens have been examined from the following states: Texas, Colorado, Kansas, Nebraska, North Dakota, South Dakota, Wyoming, Idaho, Utah, New Mexico, Arizona, and California.

This species is very similar to *texanus* and has undoubtedly been confused with it in most collections. The females may be distinguished by the sculpturing of the dorsal surface of the propodeum; the males, by the markings on the hind legs.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

BOTANICAL SOCIETY

267TH MEETING

The 267th regular meeting was held in the assembly hall of the Cosmos Club, October 1, 1935, President W. W. DIEHL presiding, attendance 70.

Notes and reviews.—J. B. S. NORTON reviewed the recently issued volume 2 of Hutchinson's *The families of flowering plants.*

Program.—W. C. LOWDERMILK: *Notes on the Third International Congress of Soil Science, Oxford, July 30–Aug. 7, 1935.*

CHARLES DRECHSLER: *Notes on the Deutsche Botanische Gesellschaft, Cologne, Aug. 28–Sept. 2, 1935.*

Reports on the Sixth International Botanical Congress, at Amsterdam, Sept. 1–7 were made as follows: Phytopathology by CHARLOTTE ELLIOTT; physiology by A. M. HURD-KARRER; taxonomy by DORIS HAYES; mycology and bacteriology by CHARLES THOM.

268TH MEETING

The 268th regular meeting was held in the assembly hall of the Cosmos Club, November 5, 1935, President W. W. DIEHL presiding, attendance 92. G. H. COLLINGWOOD, S. L. EMSWELLER, JEWELL G. GLASS, MAX M. HOOVER, M. T. JENKINS and HAROLD H. SMITH were elected to membership.

Notes and reviews.—ROLAND W. BROWN reported the finding of a specimen of *Hamamelis* in Pennsylvania with rose-colored petals. This form has been previously mentioned by Sargent.

M. B. WAITE discussed the competitive effects of the outdoor flower business upon the cut-flower trade, as well as certain aspects of autumnal coloration.

H. B. HUMPHREY reported on the differences in leaf-fall and coloration between the District and Maryland.

Program.—L. W. KEPHART: *The place of botany in weed research.*

J. A. MARTIN: *The classification of American wheats.* A review of Technical Bulletin 459 of the United States Department of Agriculture by J. A. Clark and B. B. Bayles, with a further discussion of the work of the Division of Cereal Crops and Diseases of the Bureau of Plant Industry along the same lines.

H. B. HUMPHREY: *The epiphytotic of black stem rust in 1935.* Discussed by Messrs. CLARK, HASKELL, LEIGHTY, LUDWIG and WAITE.

269TH MEETING

The 269th meeting was held in the assembly hall of the Cosmos Club, December 3, 1935, President W. W. DIEHL presiding, attendance 97. IRVING W. DIX and JOSEPH J. STROUP were elected to membership.

Program.—W. W. DIEHL: *An outline of mycogeography.* Distribution of fungi over the earth is only partly in conformity with the better known distribution of seed plants in life zones,—and then chiefly when that is necessitated by a restricted obligate parasitism or saprophytism. There are other provinces of fungus distribution made up of endemics which overlap these life-zones. Recognition of endemic provinces and of provinces conforming to life-zones is complicated by the great number of species of fungi which

are cosmopolitan in distribution. This cosmopolitanism is being increased through the influence of man in aiding many species to surmount the barriers which formerly restricted their distribution. (*Author's abstract.*)

35TH ANNUAL MEETING

The 35th annual meeting was held immediately following the adjournment of the 269th meeting. The recording secretary reported that 34 new members had been elected during the past year, bringing the membership of the society to 249, of whom 243 were active and 6 honorary. Two members passed away during the year, DAVID GRIFFITHS and W. W. EGGLESTON. A biographical sketch of the former was prepared by H. B. HUMPHREY and read by E. O. WOOTEN who gave in addition personal recollections of the deceased. A. B. CLAWSON read an obituary of Mr. Eggleston. Four members who had retired from professional work during the course of the year were elected to honorary membership, LESTER H. DEWEY, C. L. SHEAR, WILLIAM STUART and MERTON B. WAITE.

The following officers were elected to serve for the ensuing year: President, JOHN W. ROBERTS; Vice-President, CHARLES F. SWINGLE; Recording secretary; G. F. GRAVATT; Corresponding secretary, ALICE ANDERSEN; Treasurer, NELLIE W. NANCE. CHARLES DRECHSLER was nominated as vice-president of the Washington Academy of Sciences representing the Botanical Society of Washington.

CHARLES F. SWINGLE, *Recording Secretary*

Obituary

ALBERT SPEAR HITCHCOCK, principal botanist in charge of systematic agrostology, Bureau of Plant Industry, U. S. Department of Agriculture, died on shipboard, December 16, 1935, while en route home from the 6th International Botanical Congress at Amsterdam and a period of study in European herbaria. Doctor Hitchcock was born September 4, 1856, at Owasso, Michigan. He received the degree of Bachelor of Science in Agriculture from Iowa State College in 1884, and the Master's Degree in 1886. The same institution awarded the doctorate in science in 1920. Following a brief experience as an assistant in chemistry, he turned definitely to a botanical career as an instructor in botany at Iowa College for the years 1886–89. After spending the years 1889–91 as a botanical assistant at the Missouri Botanical Garden he became Professor of Botany at the Kansas Agricultural College, remaining in that position until 1901 when he was called to the Bureau of Plant Industry, at Washington, as Assistant Agrostologist. Merited promotion brought him the title of Agrostologist in 1905, Senior Botanist in charge of systematic agrostology in 1924 and Principal Botanist in 1928. For many years he was Custodian of Grasses of the U. S. National Herbarium, Smithsonian Institution. During 1919 he was a member of the National Research Council.

Doctor Hitchcock was not merely an herbarium botanist, but had travelled and botanized in the field to an extent equalled by few botanists. His travels in quest of grasses and botanical information had taken him into all the states of this country, Canada, including the Arctic regions, Labrador, Alaska, the West Indies, South America throughout its length, Europe, Hawaii, the Philippine Islands, China, Indo-China, and Japan. His numerous and authoritative publications have covered the field of systematic agrostology, culminating in the recently issued monographic masterpiece, *Manual of the grasses of the United States.*

Doctor Hitchcock was president of the Botanical Society of America in 1914. He was also a member of the Washington Academy of Sciences, the Botanical Society of Washington (President, 1916), the Biological Society of Washington (President, 1923), the Washington Biologists' Field Club, and the Kansas Academy of Sciences.